205

The Rural Science Series

L. H. BAILEY, Editor

THE COMMERCIAL APPLE INDUSTRY OF NORTH AMERICA

The Rural Science Series

EDITED BY L. H. BAILEY

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COMMERCIAL APPLE INDUSTRY OF NORTH AMERICA. *Folger and Thomson.*
THE SWEET POTATO. *Hand and Cockerham.*

Plate I.— Typical western New York scene. Full bearing trees forty to fifty years of age.

THE COMMERCIAL APPLE INDUSTRY OF NORTH AMERICA

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TO

EDWARD H. THOMSON

WHOSE VISION, ENCOURAGEMENT AND WISE COUNSEL
HAVE BEEN OF THE GREATEST AID IN THE
PREPARATION OF THIS WORK
THE AUTHORS
INSCRIBE THE BOOK

PREFACE

In collecting material for this work, the authors have visited practically every important apple-growing county in the United States; first in connection with a special investigation of the cost of producing apples in important regions, conducted by the Office of Farm Management, United States Department of Agriculture; and later as Fruit Crop Specialists engaged in organizing a system for estimating important fruit crops and particularly the commercial apple crop of the United States. The authors were impressed with a need of this kind of book, as the many published works on the apple have not dealt systematically with the commercial phase of apple-growing which only recently has become a well defined industry entirely separate from the home orchard. The whole subject of propagation has been omitted, as this is now well treated in separate books. The apple is approached in this book from the point of view of commerce.

In the preparation of this work, credit is due to Roy E. Marshall and Fred R. Motz of the Virginia Station for aid in the chapter on pruning; to Prof. W. H. Chandler of Ithaca, New York, for his advice and suggestions; to E. H. Siegler and W. V. Cruess, and to many others both in the Federal Department of Agriculture and the various state schools of agriculture and experiment stations.

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THE AUTHORS.

TABLE OF CONTENTS

CHAPTER I

CHAPTER II

CHAPTER V

CHAPTER VI

CHAPTER VII

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XIII

CHAPTER XIV

CHAPTER XV

CHAPTER XIX

LIST OF PLATES

THE COMMERCIAL APPLE INDUSTRY OF NORTH AMERICA

CHAPTER I

IMPORTANCE AND HISTORY OF THE APPLE INDUSTRY

The object of this work is to deal particularly with the commercial phases of the apple-growing industry with reference to: (1) Distribution of important commercial plantings under which heading will be discussed the advantages and disadvantages of various regions; (2) economic problems such as cost of production and marketing; (3) scientific cultural methods.

In presenting the subject, attention is first given to the geography of commercial apple-growing in the United States and competing foreign countries. It is important to know not only where commercial apples are grown but also the cultural methods employed in different regions. The wide distribution of apple plantings in the United States and the extreme variation in the character of the orchards makes it difficult for one to determine the relative importance of any region, much less to have a definite conception of the conditions which prevail in remote districts.

Few agricultural enterprises have experienced the vicissitudes which seem inherent in the fruit-growing in-

dustry. No small factor in bringing about the changing fortunes of the apple-growers has been a lack of definite information regarding the status of the industry in competing regions Temporary high prices determined in a large measure the rate of planting in most sections. Census figures giving agricultural, but not commercial, production of apples, have been used in forecasting cycles of either over- or under-planting. In census figures no line was drawn between commercial and agricultural production. Many times when the agricultural production was decreasing, the commercial production, or that portion of the crop which reaches the market and affects prices, was actually increasing, in some instances very materially. A sharp line must, therefore, be drawn between commercial and non-commercial production if we are to make a correct analysis of the industry and view the future in the proper light.

It has been only within comparatively recent years that commercial apple-growing in the United States has experienced such a very noticeable change from what might be termed a local, home orchard or semi-commercial enterprise into a highly specialized and scientific industry of national proportions, centralized in certain favored localities, involving intensive and technical methods of culture, and necessitating very complex and intricate methods of distribution and marketing. In other words, the apple crop has been taken from the list of general farm products and has been placed among the foremost specialized crops.

In 1919 the apple crop of the United States was valued at $275,463,000. It ordinarily ranks about ninth in the list of farm crops, being exceeded in total value only by wheat, oats, cotton, corn, potatoes, barley, hay and tobacco.

Some idea of the relative importance of the apple crop may be obtained by a study of the following table:

TABLE I.—ESTIMATED VALUE OF IMPORTANT CROPS OF THE UNITED STATES, BASED ON FIVE-YEAR AVERAGE 1914–1918

Corn	$2,634,804,000
Wheat	1,198,737,000
Hay	1,132,276,000
Cotton	1,097,039,000
Oats	773,752,000
Potatoes	372,239,000
Tobacco	208,426,000
Apples	184,774,000

DECLINE OF FARM ORCHARDS

At present commercial apples can be grown successfully only when scientific and intensive cultural methods are employed. The farmer can no longer give his orchard indifferent care and expect to compete with the commercial grower. With the advent of new districts, competition has necessitated the adoption of improved methods marking the decline of the farm orchard and the corresponding rise in importance of specialized commercial plantings.

About 1850, apple-growing began to assume important commercial proportions, but for many years the farm orchards remained an important factor. The demand for apples in the towns and cities was at first supplied from the farm orchards in adjacent territory. No great effort was made to locate distant markets and in years of heavy production most of the crops would remain on the farm. About 1860 certain highly productive sections of western New York demonstrated their superiority in producing high quality fruit and this fruit outsold that from other districts. These inherent advantages overcame the dis-

tance from market so that the center of commercial apple production was established and has remained in western New York. (See Plate 1.)

Despite the rapid centralization of commercial plantings in more favored regions, the apple is adapted to a wide variation of soil and climatic conditions, and is widely cultivated throughout the United States. A great many farms produce a few more apples than are needed at home. Many of these go to waste, but sometimes the surplus is pressed into cider, used for other by-products, or in some quantity finds its way into commercial channels during the years when prices warrant. Just how great a part the last factor plays in the commercial apple industry is difficult to determine, but obviously in the aggregate it is of no little importance. Particularly is this true throughout such states as Iowa, Illinois, Ohio and Pennsylvania where apples from farm orchards are hauled to nearby towns and supply the market which might otherwise exist for the so-called "strictly" commercial crop. The line of distinction between commercial and non-commercial production is being more and more closely drawn, however, so that the strictly commercial crop stands out in sharp contrast.

Practically speaking, the spraying operation gives rise to one of the first sharp distinctions between commercial and non-commercial orchards. Insect pests and diseases have exacted a heavy toll from unsprayed orchards and to-day thousands of acres of farm orchards, especially east of the Mississippi River and in such states as Pennsylvania, Ohio and Kentucky are slowly dying out. When it is known that more than 90 per cent of the orchards in some states have never been sprayed, the wide disparage-

TABLE II.— AVERAGE COMMERCIAL AND AVERAGE TOTAL PRODUCTION OF APPLES IN UNITED STATES FOR FOUR YEARS. (1916–1919)

State	Commercial Crop Bbls.	Total Crop Bbls.		Percentage of total crop which is commercial
1. Washington	5,062,000	(2)[1]	6,431,000	78
2. New York	4,132,000	(1)	9,106,000	45
3. Virginia	1,785,000	(4)	3,758,000	45
4. California	1,246,000	(6)	2,435,000	51
5. Michigan	1,133,000	(5)	2,531,000	44
6. Illinois	1,045,000	(10)	1,731,000	60
7. Pennsylvania	988,000	(3)	4,526,000	22
8. Missouri	916,000	(8)	2,008,000	46
9. West Virginia	892,000	(9)	1,784,000	50
10. Oregon	886,000	(11)	1,430,000	62
11. Colorado	683,000	(21)	851,000	80
12. Ohio	629,000	(7)	2,014,000	31
13. Idaho	589,000	(20)	844,000	70
14. Kansas	500,000	(25)	705,000	71
15. New Jersey	493,000	(23)	757,000	65
16. Arkansas	476,000	(22)	809,000	59
17. Maine	441,000	(12)	1,334,000	33
18. Massachusetts	307,000	(17)	940,000	33
19. Indiana	304,000	(16)	974,000	31
20. Maryland	279,000	(24)	757,000	35
21. Vermont	207,000	(26)	588,000	35
22. North Carolina	186,000	(13)	1,232,000	15
23. Iowa	182,000	(18)	897,000	22
24. Delaware	169,000	(36)	224,000	75
25. Nebraska	164,000	(32)	398,000	44
26. Tennessee	161,000	(15)	1,173,000	14
27. New Hampshire	157,000	(29)	441,000	36
28. New Mexico	156,000	(35)	298,000	52
29. Utah	123,000	(37)	214,000	58
30. Connecticut	117,000	(28)	446,000	23
31. Wisconsin	117,000	(19)	883,000	13
32. Kentucky	115,000	(14)	1,208,000	10
33. Georgia	101,000	(27)	474,000	21
34. Montana	86,000	(34)	324,000	27
35. Minnesota	51,000	(30)	423,000	12
36. Oklahoma	35,000	(33)	344,000	10
37. Texas	24,000	(38)	144,000	17
38. Rhode Island	22,000	(40)	78,000	28
39. Alabama	20,000	(31)	404,000	5
40. Arizona	16,000	(41)	46,000	35
41. South Dakota	4,000	(30)	105,000	4
U. S.	25,001,000		56,502,000	44

[1] Figures in parentheses rank states in order of importance in total production.

ment between the agricultural and the commercial crop is not surprising.

Table II shows the average agricultural and commercial apple production in the different states for the period 1916–1919 inclusive. It will be seen that of an average total production of approximately 56,000,000 barrels, only 25,000,000 are commercial. In other words, about 44 per cent of the total production during this period reached commercial channels.

Apples used for by-products are not included in the commercial crop. Allowing for this factor, it would still appear that from 40 to 45 per cent of our total apple crop is either consumed in the county where grown or goes to waste.

CENTRALIZED PLANTINGS IN FAVORED REGIONS

The centralization of commercial plantings in favored regions has been an interesting process. The most notable feature in the development of the apple industry has been the rapidly increasing commercial crop from western states, particularly Washington, Oregon, Idaho, California and Colorado. Twenty years ago commercial production in these states, with the exception of California, was practically negligible. To-day over 40 per cent of the commercial apple crop of the United States is grown in the Far West and at no distant date western production may represent one-half of this total. Although far from the centers of population and markets, millions of dollars have been expended in the development of apple orchards in the irrigated valleys of far western states. Heavy yields and fine market quality have combined to overcome the disadvantages of long shipments to market.

Along with the development of the commercial apple industry there has been built up, and particularly in recent years, extensive machinery for the handling, distributing and marketing of apples. Sectional lines have been broken down and this product has become distinctly a national and even international commodity of exchange. Thousands of cars of this fruit move across the entire continent and large cargoes are exported to Europe, Australia and South America. New and interesting relations between the producer and consumer have been established in an intricate system of marketing. Competition in the production of high quality fruit has worked great changes in cultural methods. Scientific investigation has thrown light on many phases of the industry, all of which will require separate treatment.

OUTLOOK FOR THE APPLE INDUSTRY

Apple production does not respond quickly to supply and demand, and for this reason there tends to be less stability in the matter of prices than with other products. It requires several years for trees to come into full bearing, and over-production as the result of excessive planting is not felt for a considerable period. If the production of potatoes, wheat or oats exceeds the demand, the land can be put in other crops. But when it has required ten or fifteen years, and much expense, to bring an apple orchard to bearing, the owner is loath to pull out his trees and will usually wait several years in the hope that price and production will become adjusted.

The history of apple production in the United States has run in cycles. In the middle of the past century, when apples first began to be grown commercially, prices

were good. During the decade 1865 to 1875, prices continued high, and during the period 1850 to 1875 over half of the present bearing orchards in western New York were set. Over-production began to be felt in about 1880. From this time on commercial production increased and prices fell until 1896, when the 76,000,000 barrel crop (agricultural) was grown and the industry reached low price ebb.

From 1890 to 1896 many growers pulled out their trees, confident that the good prices would never return. Very little planting was undertaken in this period. In about fifteen years prices began to climb back until the crest of another wave was reached between 1907 and 1911. As prices improved, beginning in 1900 and continuing up until 1908–9, there occurred another heavy planting period which assumed the proportions of a boom in many western states. It was during this period that most of the acreage in such box-apple sections as Yakima, Wenatchee, Hood River, southern Idaho and Colorado, which in 1919 produced nearly half of the commercial apples in the United States, was set. Five consecutive failures in the Ozark, Missouri, crop, from frost-injury, contributed to this inflation by creating a strong demand for northwest fruit in a territory ordinarily supplied.

The productiveness of such valleys as the Yakima and Wenatchee in Washington was phenomenal. Trees were young and free from disease, the yields on bearing trees were unusual and the returns to the acre were far greater than had been thought possible from any commercial orchard. Gross sales sometimes exceeded $2,000 an acre and in some instances orchards sold for as high as

$3,500 an acre. The price for raw land reached $500 to $1,000 an acre. A reaction in prices followed this period of heavy planting and the country is just now recovering from the effects of the boom.

While once suffering from inflation, such districts as Yakima, Hood River, Wenatchee and other well known valleys have been and will remain as centers of production. Unfortunately, however, a large acreage of land unsuited to commercial production was set to trees and exploited as apple land, with disastrous results to investors. Projects including thousands of acres of land were laid out and planted to trees in some states only to fall into entire neglect. Thus far there has never been any concerted movement toward actually pulling out trees. However, to the same effect, many trees receive little or indifferent care and never attain full commercial bearing. This is the principle which tends to limit production. Growers slip behind, omit cultivation and spraying and other necessary cultural operations, with the result that their orchards will not produce commercial fruit. It is for this reason that census figures, giving mere number of trees, are very often misleading and need careful analysis without which the industry may be led into periods of over- and under-planting.

Favorable factors.

It is often asked by those who contemplate setting an apple orchard whether it will be a good business proposition or whether there will be over-production in the years to come. A definite reply is impossible. However, a careful study of these points, in the light of present facts

and conditions, leads to certain probabilities. The following factors are favorable to the future of the apple industry.

1. *Increase in population.*

The first point to be considered is the probable increase or decrease in consumption. There may be periods of very heavy planting, but if population and demand increase proportionately, an equilibrium is maintained. Obviously the most favorable factor in the outlook is the rapid normal increase in the population of the United States. If the same rate of increase continues, in 1930 there will be 130,000,000 people, while in 1940, when many of the apple orchards not yet in bearing will reach their highest productivity, there will be 165,000,000 people. If the same rate of increase continues until 1950, there will be 210,000,000. Rate of increase in population depends, of course, on a number of factors.

2. *Movement to the city.*

The important factor in the increase in population is that there is a constantly increasing percentage living in cities and towns. For example, in 1790 96 per cent of the inhabitants lived on farms and only 4 per cent lived in towns and did not raise the food they consumed; in 1860 84 per cent lived on farms and 16 per cent in towns; in 1880 44 per cent on farms and 56 per cent in towns; in 1900 35 per cent on farms and 65 per cent in towns and in 1910 30 per cent on farms and 70 per cent in towns. The drift towards the city is distinctly in the orchardist's favor. In fact, this would seem to be the

most favorable of all factors in the outlook of the apple industry and a potent influence against over-production.

3. *Development of foreign market.*

In past years varying quantities, seldom exceeding two million barrels of the best apples, were exported annually. There are great possibilities in the export trade, not only in those countries which at the present time consume large quantities of American apples, but also in undeveloped foreign markets. South America is as yet a market largely undeveloped.

At present, the United States produces the larger part of the world's commercial apple crop. Most of this is consumed at home. In addition, foreign fruit is imported to the value of hundreds of millions of dollars from countries which do not consume apples except in a very limited quantity. The apple is one of the least perishable and at the same time one of the most popular fruits, once a demand is stimulated. At present England is the leading export market. Other north European countries consume American apples in lesser quantities. When it is considered that in the face of an abundance of other fresh fruits and food stuffs the people of the United States consume over 20,000,000 barrels of commercial apples and export only about 2,000,000 barrels annually, the possibilities of export can be more fully appreciated, particularly as the European countries with their millions of population produce commercial apples only in limited quantities. It must be remembered, however, that by the time a package of high-grade apples reaches the European market, the price is out of the reach of such classes as in this country consume much of our own commercial crop.

4. *Education and advertising.*

There is no doubt that consumption of high-grade fruit has been greatly stimulated in recent years by judicious advertising. This is particularly true of the northwest apples. Advertising and educational campaigns will continue to increase consumption. The improved quality of commercial apples is unquestionably stimulating the demand for this fruit among all classes. The fruit-stand has played no small part in creating this demand by displaying and familiarizing the people of the cities with the superb quality of certain high-grade brands and varieties of apples. A large portion of the northwest boxed apple crop is retailed an apple at a time. As the consuming public becomes more and more familiar with high quality apples, the demand for this fruit becomes more and more pronounced.

5. *Transportation.*

The success of commercial apple-growing in various regions is greatly affected by transportation and railroad facilities. Some of the more southern districts, for example, have poor transportation facilities and orchards are very often located in hilly sections where hauling the fruit to the shipping point represents one of the principal costs of production. With improved roads and shipping facilities, distance from market and inaccessibility will be largely overcome.

6. *Distribution.*

With the improved storage facilities and the progress already made in distribution, it is not surprising that the domestic markets have been able to absorb the increasing

commercial apple crop. Should the apple-grower be able to duplicate even in part the distributing methods used in the citrus industry, it becomes apparent that he might share in the increased demand for high-grade fruit. The sale of oranges has increased in recent years more rapidly than population. Many potential consuming centers are represented in towns which can no longer depend on good apples from nearby farms, but are as yet scarcely touched by the present system of distribution. These will eventually be supplied and will absorb a large amount of high-grade fruit, even though at the present time a demand for such a product seems relatively slight.

Storage facilities now established in all large consuming centers have played a most important part in developing city trade. The extension of storage facilities and better methods of distribution represent one of the favorable factors in the outlook for the commercial apple industry.

7. *Improved cultural methods.*

There has been a great improvement in every phase of orchard management. Improved methods of spraying, pruning, cultivating, and the like have made possible the production of high-grade fruit. Orchard management has probably reached its highest development in the Northwest. Careful orchard management is expensive, but there is compensation in increased yield, which is the big factor in reducing cost production a unit. The commercial grower has been able to produce high-grade fruit economically, sell it at good prices and outstrip his more careless neighbor or the producer of inferior apples. In other words, keen competition is forcing the home orchard and semi-commercial fruit off the market.

8. *Increase in the use of by-products.*

One of the most favorable factors in the outlook of apple production is the increasing importance and use of apple by-products. It is only in recent years that the canned apple industry assumed great importance. Dried apples are more in demand than before. With the advent of prohibition, the demand for apple juice products is increasing greatly. Jellies, apple-butter and similar products are being manufactured in increasing quantities. The apples required in the manufacture of these by-products will remove from the market much of the low-grade fruit. Enormous by-product plants have been built in the heart of the Shenandoah-Cumberland region of the Middle Atlantic states, in western New York, in the Yakima and Wenatchee valleys of Washington and in fact in all important apple regions. Numerous breweries and distilleries have been converted into plants for the production of apple by-products.

9. *Future production.*

It is important to note, in connection with possible future production, that there has been little concerted apple planting in any part of the United States since 1910. This lack of planting can not fail to have effect on the production of the next two decades. In speculating on future production, one instinctively turns to New York State, which until very recently was credited with one-fourth of the normal commercial apple production of the United States. In the Hudson Valley are many new orchards which will increase materially the production from this region. However, in western New York, which is

responsible for the bulk of New York apple production, the average bearing orchard is over forty years of age. Although they have had a remarkable record for longevity, production can not be maintained indefinitely on these old orchards which were for the most part planted in the sixties and seventies of the preceding century. Therefore, unless planting proceeds much more rapidly than in the past, no increase and in fact a possible decrease in production can be expected from western New York.

New England apple orchards have been going back rapidly the past several years. As a matter of fact, nowhere in the eastern states with the exception of the Shenandoah-Cumberland region, in New Jersey and Delaware, does there seem likely to be any material increase in production. It is a notable fact that a great decrease has occurred in the number of apple trees all through the Middle West and although a revival of interest is serving to hold production at its present point, it does not seem that on the whole this section of the United States will show an increased apple production in the near future.

The Pacific Northwest will unquestionably show an increased production during the next several years and will be an increasingly important factor in the commercial apple situation. While the Northwest will continue to ship more and more cars of apples, there will be no such relative increase in production as that which occurred in the past ten years.

Unfavorable factors.

To mistake hopes for facts in the determination to see only the favorable side, regardless of true conditions, has been too frequent. Production in the western

states has not yet reached its maximum. Twenty-six per cent of the new planting in the decade 1900 to 1910 was in the Pacific Northwest. This region will have a normal increase in production of high quality fruit. It is, to a great extent, commercial, and most of it will reach eastern markets. This will unquestionably be the biggest factor in the apple problem. Even to-day the average apple-grower does not seem to appreciate the importance of the western crop which has grown so rapidly that it has been difficult to keep fully informed as to the normal size.

1. *Increased commercial crop.*

It is very evident that there has been an increase in the strictly commercial apple crop of the United States, census figures to the contrary notwithstanding. It is important to be on guard against statistics and figures showing decreases in acreage. The fraction of the crop which reaches commercial channels is of the greatest importance. Ordinarily the commercial crop is estimated at approximately 40 per cent of the total production. Commercial apples are defined to include only that portion of the crop which reaches strictly commercial channels. All fruit left or eaten on the farm, wasted or used for by-products, was not considered as commercial. The agricultural crop may decrease, but if there is a greater portion of it directed into commercial channels, the decrease may be more than offset by the increasing commercial crop. In many sections the commercial crop is and has been increasing rapidly during the past few years.

Even with the expected increase in population and the better distribution discussed as favorable factors, years are likely to occur when bumper crops will cause prices to

fall as low as the cost of production. However, unless there is a decided tendency towards new planting, it seems improbable that these years will be successive or very frequent. There should always be a margin of safety and these lean years should be considered by prospective apple-growers.

2. *Poor outlook for unfavored region.*

One of the principal factors in lowering cost of production is increased yields. In other words, high yielding sections have a distinct advantage and sometimes increased cost of production actually reacts in their favor by eliminating less favored regions, and thereby limiting competition. The great increase in the cost of labor and material has made it necessary to receive a price for fruit considerably in advance of that required formerly to pay the costs and leave a profit. Many sections can overcome these increased costs by increasing yields and better management. Less favored districts in so-called marginal regions will be the first to suffer. The grower who has good yields and manages well will ordinarily be successful.

3. *Danger from boom development.*

During a period of high prices for fruit, there will always be danger of land-selling booms. Promoters will buy up large tracts of land, set them to trees and then endeavor to unload on unsuspecting city men and farmers not familiar with fruit-growing. Needless to say, the growth of the industry by such methods is unhealthy and honest and intelligent growers and horticulturists should combat such efforts with merciless publicity. This is not

intended to discourage legitimate investments. Well selected farms have been known to pay for themselves in a year. Syndicate farming schemes, however, are always questionable. They sound well, but they seldom work out. Attempts of this kind were numerous a few years ago, were largely discontinued for a time, but may revive following high price years. After a few years of inactivity, "promoters" will appear to prey on a new class of investors. Careful investigation on the part of investors should enable them to determine which orchards were set to produce fruit and which were set for speculation. By curbing this speculative influence, a long step will be taken towards preventing over-planting.

Among the favorable factors mentioned in the foregoing paragraphs are the extension of foreign markets and the increase in exportations to meet this demand. In passing, one should not fail to note that in a certain part of the world there are being developed important apple-producing regions. Notable among these is Tasmania, which has produced as many as 2,000,000 cases of commercial apples and exported as many as 800,000 cases (bushels) to England in one year. Canada will be an increasingly important factor in the apple industry. Many localities are suitable for apple-growing in this country and new regions are constantly being developed.

4. *Competition with citrus fruit.*

In discussing the outlook for the apple industry, some consideration must be given to its relative status in comparison with the rapidly growing citrus fruit industry. In 1896, when one of the largest apple crops in the history of the industry was harvested, citrus fruit-growing in

the United States was comparatively in its infancy. Since 1896, citrus production has doubled and trebled in size until during the year 1917 approximately 100,000 carloads of citrus fruits were produced and sold in the United States. Of these, 54,000 carloads were grown in California alone; the remainder largely in Florida. It is difficult definitely to establish the significance of this growth in relation to the apple industry. In the first place, citrus fruits can be grown only within comparatively small areas and their production is thereby limited. Citrus-growers have perfected a better system of distribution and have placed their products in a greater number of markets. This competition may check apple consumption, but on the whole, it seems to indicate that the possibilities of apple distribution have not been as well recognized as they might have been. Citrus production has increased much more rapidly than population and yet distributing agencies have sought out markets, stimulated demand and have disposed of their vastly increased product in most instances at a profit.

Conclusions.

On the whole, although our commercial apple production may increase perceptibly in the next few years, due principally to increased production from such regions as the Pacific Northwest and the Shenandoah-Cumberland, there will be no such relative increases as in the period from 1905 to 1920.

The population is increasing, with a resulting demand for more fruit. The extension of foreign markets, better means of distribution and wider uses of the apple, combine in giving a promising outlook for the apple industry.

There seems no reason to believe that over a period of years, taking the good with the bad, apples will make any materially better returns than many other farm crops; yet apple-growing is a specialized industry and will always afford exceptional opportunity for individual effort.

HISTORY OF COMMERCIAL APPLE-GROWING IN THE UNITED STATES

The cultivated apple comes to us from prehistoric time. While several species of native crab-apples were growing wild in the forests at the time of the discovery of this country, these species have never attained commercial importance. Practically all the commercial varieties are from the *Pyrus Malus* stock, which is a native of southwest Asia and adjacent Europe and which has been cultivated since time immemorial. Crab-apples came chiefly from *Pyrus baccata,* or Siberian crab, which comes from the more northern and eastern parts of Asia.

At present the apple is the most widely cultivated and important fruit in existence, being grown in practically every country and in every climate. It has reached its greatest cultural development in the United States, which is the principal apple-producing country in the world.

It is interesting to know that apple-culture in this country developed almost simultaneously with the settling of the early colonies. Early records show that apple trees were being grown in New England within a few years after the founding of the Plymouth colony. In 1648 Governor Endicott exchanged with Wm. Trask 500 apple trees of three years' growth for 200 acres of land. Other fragmentary information taken from the history of the New England settlements indicates that apples were being

Plate II.— Low-headed trees in a Virginia orchard. Most Piedmont orchards are on rolling land of this type.

grown in that region as early as 1650, and that numerous plantings there and elsewhere had been made by 1700. Among the early varieties mentioned were Pearmain, Russetin, Long Apple and Kreton Pippins.

The two leading apple regions in New York State, the Hudson Valley and western New York or Lake Shore region, were recognized in the early development of the apple industry in New York. It appears in the early history of the Dutch settlements in the Hudson Valley that apple trees were planted near Kinderhook not long after 1700. Plantings also occurred in Long Island at about the same date.

Pioneers report apple plantings in western New York as early as 1750. It must be remembered that this region was in a much more primitive state of development at this time than the New England and Hudson Valley sections. Legendary history suggests that apple seeds preceded the progress of civilization into western New York and, falling into the hands of Indian tribes, notably the Senecas and Cayugas, were scattered throughout this part of the state. General Sullivan is reported to have found bearing apple trees laden with fruit near Seneca Lake as early as 1779.

It must not be thought that these early plantings were of commercial importance. They were isolated, small in extent, but nevertheless represented interesting landmarks in the development of apple-culture in this country. Commercial apple-growing in New York really dates back to about 1860. Prior to this time A. J. Downing, who was born in 1802 and later conducted a nursery at Newburgh, had been a very important and influencing factor in the development of the apple industry in the Hudson Valley region. A. J. Downing died in 1852 after having pub-

lished in 1845 his "Fruits and Fruit Trees of America." Charles Downing, his brother, remained a leading authority on apple varieties and apple-growing until 1885.

In 1840 George Ellwanger and Patrick Barry started the Mt. Hope nurseries at Rochester, New York. Barry was one of the pioneers in the apple industry and had much to do in making western New York the leading nursery and apple-growing region.

Jonathan Chapman, or Johnny Appleseed, the name by which he was more commonly known, had much to do with the spread of the apple westward from New York. Chapman was an eccentric character. It seems that he spent much of the first half of the nineteenth century in roaming through Ohio and Indiana, at that time a wild undeveloped country. By carrying apple seeds about with him and sowing them broadcast, he effected a wide extension in apple plantings throughout this region. Being of an intense religious nature, his life and activities have a romantic interest which have been the subject of much writing. His descendants are actively interested apple-growers in southern Ohio to-day.

From the standpoint of historic interest, few regions excel the Piedmont of Virginia. Although the Newtown apple originated on Long Island, it was later introduced into Albemarle County, Virginia, early in the eighteenth century and has been prominently identified with the development of the apple industry in this region, under the name of Albemarle Pippin. Albemarle Pippins were exported to England from Virginia as early as 1759. Thomas Jefferson was cultivating this variety at Monticello, his country place in Virginia, before the Revolution. It has been authentically stated that so pleased was Queen Victoria

with several barrels of Virginia Albemarle Pippins presented to her during the first year of her reign by the late Arthur Stevenson, American minister to England, that she caused the import tax on apples to be removed. Since that time apple exportations to England have rapidly increased.

While certain species of wild crabs are native to the prairie states and doubtless isolated plantings occurred in this region prior to the Civil War, it was after 1860, at the time of the influx of many early pioneers, that apple trees were brought into the country west of the Mississippi River. The apple industry in this section did not begin to assume commercial importance until the eighties and the decade following. It was at this time that many of the older orchards were planted in the Ozarks, Missouri River region and southern Illinois. Good prices for apples in the late eighties stimulated planting and it was during the nineties that the heavy commercial apple plantings were made in the Middle West.

The rapidly increasing importance of the western apple regions attracts considerable attention to the history and development of apple culture of the Far West. Probably the first apple trees on the Pacific Coast were grown at Fort Vancouver, Washington, where employees of the Hudson Bay Company are reported to have planted seeds, carried from England, as early in 1825.

The Pajaro Valley or Watsonville section of California is the oldest commercial apple region in the Far West. The agricultural history of this region dates back to about 1820 when Don Antonia Maria Castro applied to the government of Spain for a grant of land along the Pajaro River, which he called Vega del Rio del Pajaro. Several large land grants were given to the Spanish Dons during

the next twenty years, but all were used for stock-raising.

In 1853 the first apple orchard planted by an American in this region was set out on the Jesse D. Carr place, now the Sillman homestead. This orchard was about two acres in extent and contained a mixture of fruit. Some of these trees are still in bearing. The second apple orchard in the Pajaro Valley was planted by Wm. F. White in 1854. These first two plantings were home orchards. The first commercial orchards in the Pajaro Valley were set out by Isaac Williams and Judge R. F. Peckman in 1858. One planted thirteen acres and the other six acres. The early varieties grown were Smith's Cider, Rhode Island Greening, Gravenstein, Newtown Pippin and Belleflower. The first shipment of apples from the Pajaro Valley was made in 1867 by Isaac Williams who sold his fruit in San Francisco. Increased demand for fruit stimulated apple planting and a large number of the present orchards were set out in the period between 1880 and 1900.

The output of the Watsonville section was assuming commercial proportions many years before such sections as the Yakima and Wenatchee valleys in the Northwest had come into prominence.

It is generally thought that the oldest apple orchards in the Yakima Valley were planted about 1875 to 1876. Near Fort Simcoe, twenty-seven miles south of North Yakima, stands an orchard planted by an Indian, Klickitat Peter, in 1877. This is probably the oldest apple planting in what was later destined to become one of the premier apple-growing regions.

In 1888 there were a few family orchards in the Yakima district, but probably the first commercial planting of

fruit-trees in Yakima was made in 1888 by H. J. Bicknell, in what is known as Parker Bottom. In the spring of 1889, Fred Thompson set out in the same locality what was probably the first commercial apple orchard in the valley. The whole planting consisted of ten acres and included three acres of prunes, three acres of peaches, three acres of Ben Davis apples and one acre of pears.

In 1888 and 1889 two irrigation companies, one to undertake the Selah project and the other what is now the Sunnyside Government project, were organized. At this time a few express shipments of fresh fruit had been sent to the coast from the small home orchards.

In 1894 the total apple output shipped from the Yakima Valley probably did not exceed twenty-five cars. Fruit was layer packed, but not wrapped, the old sixty-pound box being in common use. In 1896 Fred Thompson shipped from the Yakima Valley what was probably the first car of fruit from this region to be sold east of the Mississippi River. It was in 1894 that the apple planting period really began, and the most extensive plantings were made in the years 1900 to 1908.

The history and development of the Wenatchee Valley, which is probably the most intensive apple region in the country, was even more recent than the development of the Yakima Valley. The date of the first apple plantings in Wenatchee is given by some as 1873, others 1876. The first fruit-trees were set out by Miller Brothers who later established the first irrigating ditch in this region in 1883.

Practically the entire Wenatchee Valley was a barren waste until 1896 when the Gunn ditch was built to water 600 acres of land. In 1901 W. T. Clark, coming from North Yakima, interested himself in the organization of

the High Line Canal, designed to water 9000 acres of orchard land. This ditch was completed to Wenatchee in October, 1903. The completion of the High Line Canal marked the beginning of important orchard development in the Wenatchee Valley. By 1913 there were about 20,000 acres of irrigable land under the different ditches established in the Wenatchee Valley.

The Indians occupied the Grand Valley until 1880, at which time the history of fruit-growing in western Colorado begins. In the spring of 1883 several hundred root-grafts were put out in the Grand Valley, only a fraction of which lived. The first fruit plantings were made in the lower lands of the Valley about 1885 or 1886. In 1882 a farmer living at Paonia, in Delta County, a locality of lesser importance than the Grand Valley, purchased twenty-six trees of mixed varieties from Rochester, New York, at one dollar each. Of these, three survived. As in the Yakima and Wenatchee valleys, principal orchard development occurred in Colorado after 1900.

From this fragmentary history of apple-culture in the United States, it may be seen that while apple trees have been grown in home orchards for nearly 300 years, it has only been within comparatively recent years that the industry has assumed commercial proportions.

SCIENTIFIC CLASSIFICATION

The apple belongs to the important genus Pyrus, of the Rose family (Rosaceæ). This genus includes the apples and pears. The common apple is *Pyrus Malus,* supposed to be native to Europe and Western Temperate Asia. Within this species, as it is commonly broadly accepted, are included the commercial apples, the Paradise and

Doucin dwarf forms, so-called bloomless apple, and others. The Siberian crab is *Pyrus baccata*. The growth is more slender and wiry than in *P. Malus*, twigs and leaves not woolly as in that species, the fruit small, long-stemmed, and with the calyx falling away at the blossom end. Hybrids occur between *Pyrus Malus* and *P. baccata*. Some of the apples known as "crabs" are only small and acrid fruit-forms of *P. Malus*.

Several species of crab-apple are native to North America. One of them is *Pyrus ioensis*, the prairie crab. It is not cultivated for its fruit, but the Soulard, Fluke, and others are supposed to be hybrids between this species and *Pyrus Malus*.

Some botanists separate the pears and apples into different genera. Under this disposition, the pears are retained in Pyrus and the apples take the generic name Malus. The common apple then becomes *Malus communis*, and the wild or run-wild form of it in Europe is called *M. sylvestris*.

A number of oriental species of Pyrus (Malus) are grown for ornament, but they need not be discussed here.

CHAPTER II

LEADING APPLE REGIONS OF THE UNITED STATES

There has been a noticeable tendency in recent years towards the centralization of the commercial apple industry in a relatively few intensive regions. A glance at the

Fig. 1.— The principal apple-growing regions in the United States.

outline map showing the principal apple-growing regions reveals this. (See Fig. 1.) It is estimated that approximately 80 per cent of the total commercial apple crop of

the United States is produced in these relatively few restricted districts. In many parts of this country there is scarcely a farm that has not a small home orchard of apple trees. As has been emphasized elsewhere, production from these home orchards is having less and less commercial significance and interest centers in a few well-defined regions.

By describing each important apple region and pointing out its individual characteristics, it is hoped to convey to the reader a mental picture of the commercial apple industry as it has been developed in these well-favored regions.

WESTERN NEW YORK (PLATE I)

From the standpoint of quantity production and total acreage, western New York is the most important apple region in the United States. As early as 1860 the productivity of this section became apparent, and the high quality apples outsold those from other localities. Good quality and high yields were sufficient to overcome the advantages which many other regions may have enjoyed from being closer to the Atlantic seaboard cities; and the center of commercial barreled apple production was established and has remained in western New York.

Previous to 1919, one-fourth of the normal commercial apple crop of the United States was produced in the state of New York, but the Northwest now produces so many apples that this will probably never be true again. Heaviest plantings are in Niagara, Monroe, Orleans and Wayne counties which border on Lake Ontario. Each of these counties has an apple acreage of 25,000 to 35,000 acres and each is capable of producing from a half to a million barrels of apples annually. Counties of less importance

included in this region are Ontario, Yates, Seneca, Cayuga, Genesee, Onondaga, Oswego, Wyoming and Tompkins.

In reality, the world's most important barreled apple region is largely in a ten-mile belt along Lake Ontario, extending from Niagara Falls to Oswego, New York, a distance of about 125 miles. In this section much of the present bearing acreage was planted in the late sixties and in the seventies of the preceding century. In other words, the average age of bearing orchards is over forty years. Probably nowhere else in this country will trees retain such vigor and productivity at forty to fifty years of age as in western New York. The old apple orchards along the ridge road from Buffalo to Rochester have withstood alternate periods of neglect and care, according to the vicissitudes of the apple industry, and yet they remain in most instances vigorous and productive at advanced age.

The permanency of western New York as a leading apple region may be explained partly by the conservatism of the New York grower. Instead of devoting himself entirely to apples, the average farmer in western New York has 100 acres or more of farm land of which only 10 to 20 acres are in apples. His other crops have maintained him in poor apple years. The yields on the commercial full bearing orchards average from 75 to 100 barrels to the acre.

Some idea of the importance of New York as an apple state may be gained from the fact that the 1918 commercial apple crop was estimated at 5,950,000 barrels, over two-thirds of which came from western New York. Baldwin represents nearly one-half and Rhode Island Greening about 20 per cent of the total production. Northern Spy, Roxbury Russet, Tompkins King, Duchess of Oldenburg,

Hubbardston, Wealthy and Twenty Ounce comprise the greater part of the remaining commercial production.

As might be expected, large storage plants have been built in nearly all of the apple towns. Some of the more important apple centers are Rochester, Lockport, Medina, Albion, Brockport, Sodus, East Williamson, North Rose, Canandaigua and Holcomb. The barrel is used almost exclusively and very little of the crop moves in bulk.

A high percentage of the dried apple production of this country comes from the western New York apple region. For many years Wayne County has been the center of dried apple production and in some seasons as much as 40 per cent of its crop is used for drying. Nearly every orchardist in this county has his own drier, and the production comes largely from small home driers rather than from large commercial plants.

There is considerable variation in the types of orchards in western New York. Probably 80 to 90 per cent of the bearing orchards are over twenty years of age and there are many profitable orchards over fifty years old. It is believed that the trees in this region reach their maximum bearing capacity at forty to fifty years. The earlier plantings were set about 33 x 33 which proved too close on account of the large size which the trees attained. New plantings are being made 40 x 40.

Orchard values in western New York have never reached the high figure attained in some apple regions. Seldom are bearing orchards valued at more than $500 an acre. It is difficult to give orchard values in any region and particularly in western New York where the orchard usually goes with the farm and where varying care is given. Some orchards are worth little more than the land they

occupy. These are the old orchards which have received indifferent care for many years.

HUDSON VALLEY

The Hudson Valley is one of the well known eastern regions, the important commercial plantings extending along the Hudson River from Saratoga County south to Westchester County, and including both sides of the valley for a width of several miles. The normal production for this region is about 600,000 barrels and originates largely in the counties of Columbia, Dutchess, Greene and Ulster, with lesser amounts in Albany, Saratoga, Rensselaer, Orange, Putnam and Westchester. The industry is very intensive about the towns of Coxsackie, Ravena, Germantown, Red Hook, Millbrook, Athens, Milton and Ulster Park.

Much of the land is rough and hard to work and this region is not as well adapted to general farming as western New York. The soil in some instances is more or less deficient in fertility.

The varieties grown are principally Baldwin, Greening, Ben Davis and Spy, with considerable commercial quantities of McIntosh, Duchess, Gravenstein, Holland Pippin, Fall Pippin, English and Roxbury Russet.

Trees are much the same in age as in western New York, the orchards in many cases being even older. However, there is a larger proportion of young plantings and orchards coming into bearing in the Hudson Valley than in the western part of the state and particularly is this true of Dutchess and Columbia counties.

The apples from the Hudson Valley are shipped largely by boat and rail to New York and eastern markets. Many

apples are grown here for the fancy trade demand and such varieties usually bring good returns, due to the proximity to market. The average annual yields are less than in western New York, due largely to soil conditions. The future of the Hudson Valley fruit industry seems assured on account of its proximity to market.

NEW ENGLAND BALDWIN BELT

The intensive apple sections of Maine, New Hampshire and Massachusetts are included in what is known as the New England Baldwin Belt, so called on account of the prominence of the Baldwin variety. Beginning in southern Maine, this region extends through southern New Hampshire, Massachusetts, and into Connecticut, including both the intensive and more scattered and outlying apple plantings in this territory. In Maine the leading apple counties are Oxford, Kennebec, Franklin and Androscoggin; in New Hampshire, Rockingham and Hillsboro; while the heaviest apple production in Massachusetts comes from Middlesex, Franklin and Worcester counties.

As above stated, Baldwin is the leading New England variety, while Rhode Island Greening, Northern Spy, McIntosh, Wealthy, Gravenstein, Tolman, Ben Davis, Porter and Stark have commercial importance. The New England apple trees, like those of New York, are for the most part old. Great numbers of them have gone out of commercial bearing in recent years and especially during the very cold winter of 1917–1918, when it was estimated that over a million Baldwin trees of this section were killed.

The gipsy moth has done heavy damage to the orchards in New Hampshire, and the commercial production for the

New England Baldwin belt has decreased within recent years. A great number of young orchards are coming in, particularly in favored spots of New Hampshire and Massachusetts, and these new orchards will tend to make up loss among older trees. Many varieties, such as Wealthy, McIntosh and other fall or early winter sorts, are proving profitable. McIntosh and Wealthy are becoming especially popular in the newer plantings. Such varieties as Stark, Yellow Bellflower, Porter, Tolman Sweet, Russets, and many other old varieties are still found in considerable quantity, but are no longer being planted.

The orchards of New England for the most part are small in size and come more nearly being farm orchards than do those of any other commercial section. They are in many cases too small to be operated profitably on a strictly commercial basis.

A large part of the New England apple crop is marketed locally, particularly in Massachusetts where many apples are shipped in bulk or hauled in trucks to Boston and nearby markets. In normal times New England exports large quantities of apples, particularly of the Baldwin variety. The barrel is the standard package for New England apples when shipped in quantity to outside markets, although for local consumption basket, box or bulk trade predominates. In many cases, strictly high-grade apples are put up in boxes. The normal commercial production for this region is about 1,250,000 barrels, and it is not likely to increase; in fact, unless planting is stimulated to a greater degree than at present, production will decrease somewhat on account of the number of old orchards which are dying or are losing their vigor. Production of high-grade fruit will increase.

THE CHAMPLAIN DISTRICT

The Champlain district includes that portion of New York and Vermont bordering on Lake Champlain and Lake George. It is situated in a very rigorous climate and only hardy varieties will grow there. It is famous for its fine quality fruit which brings high prices on the market. In area the Champlain region is small as compared with most other commercial districts. It includes the counties of Grand Isle, Addison, Chittenden and Rutland, Vermont, and the counties of Clinton and Essex, New York. The bulk of the production originates near the towns of Middlebury, Shelburne, Rutland and Danby in Vermont. From a strictly commercial standpoint, Grand Isle County, Vermont, an island in Lake Champlain, is the most important of all the counties in this region. Peru, Plattsburg, Lewis and Crown Point are towns about which the apple industry centers on the New York side.

The varieties grown in the Champlain region are McIntosh, Fameuse, Rhode Island Greening and Northern Spy. Varieties of less importance are Baldwin, Ben Davis and Wealthy. The district is best known for its McIntosh, Northern Spy and Fameuse production.

Champlain orchards are in the main much younger than those in other parts of Vermont and New York. The Grand Isle plantings, largely McIntosh, are particularly young. Although great damage was done to the whole Champlain district by the severe winter of 1917–1918, the young plantings will no doubt soon make up for this loss and bring the production up to normal. McIntosh trees survived the severe winter better than any other variety, a

fact which will stimulate their planting to an even greater degree.

NEW JERSEY

The commercial apple production of New Jersey originates largely in Burlington, Camden and Gloucester counties in the southwestern part of the state and in Monmouth County in the northeast. The southwestern apple counties of New Jersey are all within easy access by truck to Philadelphia, while Monmouth County production reaches New York City easily by rail.

In former years, plantings in the western and northwestern part of the state along the Pennsylvania border were responsible for a considerable production of winter apples, but this region has declined in importance in recent years. The new orchards in New Jersey are made up largely of summer varieties. The varieties of importance in Monmouth County are Ben Davis, Winesap, Gravenstein, English Codling, Wealthy, Twenty Ounce, Oldenburg and Red Astrachan. For the counties in the southwestern part of the state, Starr, Early Ripe, Williams Early Red and Yellow Transparent predominate, while Winesap and Stayman are favorite late varieties.

Considerable interest in apple-growing is being taken in the group of counties near Philadelphia, of which Burlington, Camden, Gloucester and Cumberland are most important. Considerable planting is being done and much young acreage is to be found in these counties. Riverton, Moorestown and Burlington are towns about which many commercial orchards are located.

The early apple crop, which makes up such a large portion of the New Jersey production, is shipped largely in five-eighths-bushel or bushel baskets. A small part of the

crop moves out in barrels, but the five-eighths-bushel basket is popular for winter as well as summer varieties. The commercial apple production for New Jersey is increasing, due to the greater output from the group of southwestern counties, including Burlington, Camden, Gloucester and Cumberland counties.

The average commercial production for the state is estimated at about 500,000 barrels, of which a considerable percentage is made up of early varieties. The commercial apple sections in New Jersey are very favorably located with respect to markets and the future of the industry in this state seems bright.

DELAWARE (PLATE III)

The apple section in Delaware is really more or less of a continuation of the New Jersey district. Varieties, methods of marketing and even soil conditions are very much the same. The commercial apple orchards of Delaware are principally in Kent and Sussex counties. Plantings are intensive about the towns of Wyoming and Bridgeville. The average production for the state is nearly 200,000 barrels, much of this being made up of early varieties which are entirely off the market by August 1st.

The early apple industry in Delaware proved profitable, especially during the few years prior to 1919, and at the present time it is experiencing a marked growth. Many new and very large orchards are being set out. Williams Early Red, Red Astrachan, Yellow Transparent and Early Ripe are particularly popular among the early varieties, while Stayman leads among the late varieties.

Large orchards are not uncommon in Delaware, there

being several commercial orchards, over 500 acres in size. For the most part, these large tracts are carefully and systematically managed, although many have not yet attained full bearing.

Delaware growers ship practically all their early fruit in five-eighths-bushel or bushel baskets, particularly the former, while the late apples are usually barreled. Delaware is primarily devoted to the production of early varieties and this has brought about its prominence in the commercial apple industry. Much of the acreage is young and an increased production is to be expected.

SHENANDOAH-CUMBERLAND DISTRICT

The Shenandoah-Cumberland district is the term applied to that section of Virginia, Maryland, West Virginia and Pennsylvania which is included in the Shenandoah and Cumberland valleys. This region has somewhat recently come into prominence and is yet only approaching its maximum production. By mentioning Frederick County, Virginia; Berkeley County, West Virginia; Washington County, Maryland; Franklin and Adams counties, Pennsylvania; and counties in close proximity to these, a more or less compact region is defined which rivals western irrigated districts in intensity and exceeds New England in normal production. A full or normal crop for the Shenandoah-Cumberland would be over 3,000,000 barrels.

The two towns about which the apple industry of this region centers are Martinsburg, West Virginia, and Winchester, Virginia. Other important apple towns are Staunton, Virginia, Chambersburg, Biglerville and Waynesboro, Pennsylvania, and Hancock, Maryland. The counties of Berkeley, West Virginia, and Frederick,

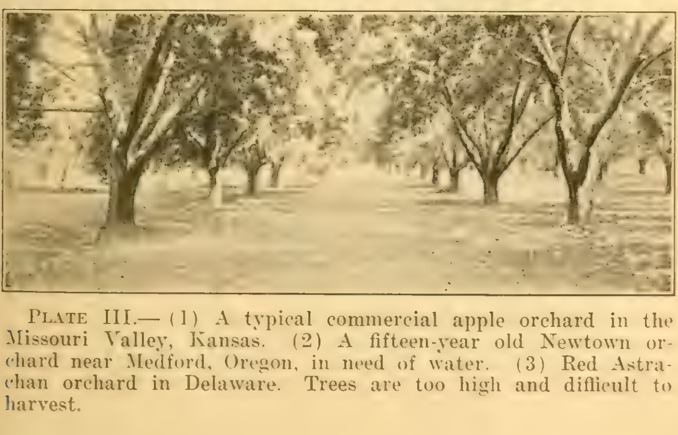


PLATE III.— (1) A typical commercial apple orchard in the Missouri Valley, Kansas. (2) A fifteen-year old Newtown orchard near Medford, Oregon, in need of water. (3) Red Astrachan orchard in Delaware. Trees are too high and difficult to harvest.

Virginia, rank among the highest producing counties in the country. Each is capable of yielding over a half million barrels of high quality fruit in good crop years. Augusta County, Virginia, has an enormous acreage of young trees and will soon rival these counties in production. Franklin and Adams counties, Pennsylvania, with but 20 to 30 per cent of their trees in bearing, produce a quarter million barrels each annually and their production is rapidly increasing. The same is true of Washington County, Maryland.

The York Imperial is the leading variety for the Shenandoah-Cumberland and the Ben Davis is second in importance. Grimes Golden, Stayman, Black Twig, Delicious and Yellow Transparent have been planted extensively. The York Imperial represents fully 40 per cent and Ben Davis about 20 per cent of the regional production. Stayman and Delicious will increase in commercial production in the upper Shenandoah Valley and particularly in Augusta County. Stayman yields are increasing very rapidly in Pennsylvania, particularly Adams and Franklin counties.

The average orchard in the Shenandoah-Cumberland is fully twenty years younger than those in New York. Most of the orchards have not yet reached maximum bearing; in fact a very large percentage of the trees are not in bearing at all; particularly is this true for Shenandoah, Rockingham and Augusta counties, Virginia, where enormous acreages are just coming into bearing.

Taken as a whole, the commercial apple plantings in the Shenandoah-Cumberland represent one of the most promising regions in the country. The trees are young, and relatively free from disease; the yields are high; plantings

are centralized; and possibilities are strong for a rapidly increasing production. Practically all of the apples are shipped out in barrels, largely to northern markets. A greater relative increase in production may be expected from this district than from any other outside of the Northwest.

PIEDMONT DISTRICT OF VIRGINIA (PLATE II)

In total production several regions excel the Piedmont of Virginia, but in historic interest and beauty it is unsurpassed. The Piedmont region extends from Patrick County in the southern part of Virginia, north along the eastern slope of the Blue Ridge Mountains to the Potomac at Loudoun County. This area includes the famous Albemarle Pippin and old Winesap district of Virginia, which centers in the counties of Albemarle and Nelson. Other counties of importance are Franklin, Roanoke, Bedford, Amherst, Patrick, Rappahannock, Loudoun and Culpepper. The most intensive plantings are about the towns of Crozet, Afton, Covesville, in the heart of the Piedmont, and also about Roanoke, Salem, and Stuart farther south.

The Albemarle Pippin plantings for which the Piedmont is famous are found largely in the old orchards, particularly those in the Rock Fish Valley in Nelson County and about Covesville, Crozet and Charlottesville in Albemarle County. Pippin plantings also occur in the eastern part of Nelson County and farther south through Amherst, Bedford, and as far as the Bent Mountain district in Roanoke County. Most of these Albemarle Pippin plantings of the Piedmont are well advanced in age and only a few young trees are coming on to replace them.

While the Piedmont has been best known for its Albe-

marle Pippins for more than a century and a half, the old Winesap is more widely grown and is produced in greater commercial quantities than any other variety. York Imperial represents from 15 to 20 per cent of the regional production, while Stayman and Black Twig occur in some commercial plantings. The age of the Piedmont orchards varies from a few years to a century. The oldest trees in profitable bearing are those of the Albemarle Pippin or Newtown variety which was highly prized in the English markets a century ago. On account of late bearing and susceptibility to bitter-rot, this variety is less popular in the newer plantings. Principal commercial plantings average from fifteen to twenty years of age and lean rather strongly to Winesap, Stayman and York Imperial. A full crop for this region would be about 800,000 barrels but the average is not much over 500,000 barrels.

Piedmont orchards are distinctly mountainous in character, most of them being situated on hill or mountain sides. They are somewhat difficult to work and harvesting operations are expensive. Practically all the fruit is barreled and moves to outside markets, there being little home trade. Many of the York Imperials and Albemarle Pippins are exported. While annual yields do not generally equal those of the Shenandoah-Cumberland on the west, higher quality varieties are grown and better prices are received. Among the disadvantages to be considered in this region is the prevalence of bitter-rot. Root-rot has also caused considerable loss and the growers find it impossible to control.

A considerable acreage of young trees will attain full bearing soon after 1920 and the production of this section will doubtless be increased. High quality fruit and a

progressive spirit among its growers insures growth and development of the apple industry in the Piedmont.

MINOR REGIONS IN PENNSYLVANIA, WEST VIRGINIA AND VIRGINIA

Aside from the important apple regions described, a number of minor regions throughout Pennsylvania, West Virginia and Virginia are worthy of mention.

In the northeastern part of Pennsylvania, particularly in Luzerne and Lycoming counties, are considerable commercial apple plantings of Baldwin, Northern Spy and Rhode Island Greening. These conform more to the type of orchards in western New York than to those in Pennsylvania's leading apple region in the Cumberland Valley district.

Outside of the eastern Panhandle section included in the Shenandoah-Cumberland region already described, there are no extensive commercial apple plantings in West Virginia except in Hancock County which is situated at the tip of the northern Panhandle which extends northward between Pennsylvania and Ohio. This was originally the most important commercial apple district in West Virginia, but it has long since been eclipsed by the great development in Berkeley and surrounding counties. The important variety grown in Hancock County is the Willow Twig, well known on the Pittsburg markets. The orchards are for the most part old and increased commercial production seems unlikely.

In southwestern Virginia there are many commercial orchards. This district is not included in either the Shenandoah-Cumberland or Piedmont region. The var-

ieties grown are Winesap, York Imperial, Rome Beauty, Stayman, Lowry, Virginia Beauty and Delicious.

MOUNTAIN REGION OF NORTH CAROLINA

The mountain district of North Carolina is more or less a continuation of the Virginia Piedmont. Apples have been grown in the mountains of western North Carolina for many years; it is said that many of the old plantings were for the purpose of producing apples to be used in the manufacture of apple brandy. Certainly a great many of the old orchards are located in relatively inaccessible and remote localities. It is doubtful whether more than 5 per cent of the North Carolina apple acreage has ever been sprayed.

When the manufacture of apple brandy was discontinued, it was found that there was a market for apples in their fresh state and at the present time many thousand bushels of fruit produced on the old unsprayed orchards are hauled down the mountain-sides in wagons to find their way to the market in bulk. Improved cultural practices are being adopted more and more each year.

Apple orchards are planted in the western part of North Carolina, extending from Surry County, bordering on Patrick County, Virginia, on the north, almost to the extreme southwestern corner of the state. North Carolina apple orchards represent two distinct types. While for the most part the older trees are neglected and unsprayed, there are very intensive and strictly commercial plantings in a few localities, such as in Surry County in the vicinity of Mt. Airy in the northwestern part of the state. A little farther south other commercial plantings have been set out

in the vicinity of Taylorsville and Wilkesboro. The dried apple industry has assumed considerable proportions in this locality.

The most progressive apple section in North Carolina is in Haywood County near Waynesville. Here a considerable number of strictly commercial apple orchards have been set out, which are responsible for the increasing commercial output of this section. A third important commercial region is in Polk and Henderson counties in the vicinity of Saluda and Hendersonville.

While most of the North Carolina apple crop is handled in bulk, the product from the later commercial plantings is nearly all barreled, and finds a ready sale at good prices in southern markets. In addition to the apple counties already named, some commercial planting is found in Watauga, Madison, Rutherford, Alexander, and Jackson counties.

The leading variety of the old orchards is the Limbertwig of which there are several types, including the Royal or Brushy Mountain Limbertwig. Winesap, Stayman, Delicious, and Arkansas (Black Twig) are among the new varieties predominating in the younger plantings. Production of these varieties will increase materially. The Limbertwig, although a very good apple, owes its early popularity to the fact that it is a late keeper. Better known and higher quality varieties are supplanting the Limbertwig in the younger orchards. It is quite apparent that the strictly commercial production of apples from North Carolina will be increased materially when the young plantings attain full bearing. Surry County in the northwest central part of the state, and Haywood County

in the western part, will be the main centers of commercial production.

A full crop for western North Carolina at this time would not exceed 300,000 barrels of commercial apples, of which the larger part would be sold in bulk.

MOUNTAIN REGION OF GEORGIA

While not as yet representing great commercial production, an apple region is developing in the extreme northeastern part of Georgia which is of particular interest since most of its fruit is boxed. Strictly speaking, the commercial apple district in Georgia includes but two counties: Rabun and Habersham, in the extreme northeastern part of the state. Habersham County is the more important of the two and has experienced a period of heavy planting, which promises a greatly increased commercial output. A single orchard in this region ships as many as 40,000 packed boxes of apples in a season, which is a large boxed apple crop for any orchard East or West, but more particularly the East where boxing of apples is little practiced. H. R. State, whose orchard is one of the finest and most profitable for its size in Georgia, had much to do with the early development of this region. The most intensive apple plantings are about the towns of Cornelia, Demorest, Tallulah Falls and Clarksville.

The leading variety in northeast Georgia is the Yates, which seems particularly adapted to the southern climatic and soil conditions, and has proved very popular on account of its heavy annual bearing habit. Other varieties of commercial importance are Terry's Winter, Stayman Winesap, Black Twig, Shockley and Winesap. Delicious

appears prominently in newer plantings. The Limbertwig and Nickajack are found in the older orchards, but are not common in newer ones. A very large percentage of the commercial plantings in both Rabun and Habersham counties have been made since 1910.

This region enjoys close proximity to the southern markets, and for that reason a good outlet for its fruit is assured. Several very favorable tracts of land have been set to apple trees in northeast Georgia and while for the most part these orchards are promising and well cared for, it is unfortunate that some unworthy promotion schemes have been planned for the exploitation rather than the development of the apple industry in this region. Most of the trees not yet being in full bearing, it is difficult to state the possible output; the largest crop year prior to 1919 included over 100,000 bushels of boxed apples, as well as considerable quantities shipped in bulk. A greatly increased production may be expected.

OHIO

Southern Ohio Rome Beauty district.

The Southern Ohio Rome Beauty district is fairly well-defined and centralized and has come into prominence since 1910. The most important plantings in this region are in Lawrence, Gallia, Meigs, Athens and Washington counties, bordering on the Ohio River, Lawrence and Washington being particularly noteworthy. Extensive plantings occur about the towns of Marietta, Proctorville and Gallipolis.

Apple land of this region is mountainous in character, and the orchards are very often isolated and more or less

inaccessible. On account of the rolling character of the land, orchard operations are somewhat difficult. In many cases terraces have been made to facilitate the operation of power spray outfits. It is common to find the orchards situated on the tops of the hills. Trees are set close together and do not attain the size of those in most eastern regions. Orchards for the most part are under twenty-five years of age. A lack of symmetry is noticeable in some commercial plantings on account of missing and varying sized trees. Much of the fruit is ferried across the Ohio River to Huntington and Parkersburg on the West Virginia side. These cities, together with Marietta in Ohio, are the principal distribution centers for the southern Ohio crop.

With the exception of some summer varieties which are often sold in bulk in nearby markets, most of the apples are barreled. The commercial production of the region has reached 750,000 barrels in certain years. Rome Beauty, the leading variety, originated in southern Ohio and is especially adapted to this section. Ben Davis, Grimes, York Imperial, Oldenburg and Yellow Transparent are among other important varieties grown commercially, of these Ben Davis and Grimes being most widely grown.

The average annual yields in this region are rather small and unless planting proceeds more rapidly than for the period 1915 to 1919, no greatly increased production can be expected.

Minor regions in Ohio.

Columbiana County in the eastern part of Ohio is a rather important apple county with a number of old

orchards, many of which are not very well taken care of. The leading varieties are Baldwin, Greening, Ben Davis, Hubbardston and Flushing Spitzenburg, the latter known commercially only in this locality.

In northern Ohio along the lake belt, particularly in Ottawa, Sandusky, Huron and Erie counties, are somewhat limited apple plantings consisting largely of Baldwin, Rhode Island Greening, Ben Davis, Northern Spy, McIntosh, and Duchess.

Farther south in Ohio, about midway between the southern Rome Beauty section and Lake Erie is another small apple district consisting of more or less scattered plantings about Chillicothe. Early varieties such as Yellow Transparent figure in the production of this locality.

KENTUCKY

For many years Kentucky has been credited with a very large apple production. However, this is for the most part non-commercial and originates almost entirely in old neglected orchards. The strictly commercial apple plantings of Kentucky are largely in Henderson County on the Ohio River just south of Evansville, Indiana. The apple industry has not attained very great proportions even here, although there are a number of important plantings and the orchards are generally well taken care of. The leading varieties are Winesap, Stayman, and Ben Davis, although there are considerable plantings of early kinds. In some years the total production of this small section reaches 40,000 barrels, although it is more commonly under 30,000 barrels of strictly commercial apples. The industry is being fostered in this section and further growth seems probable.

MICHIGAN

Commercial apple-growing has been an important enterprise in Michigan for forty years or more. While apple plantings are not confined to any one county or group of counties, they are centralized in the region bordering on the eastern shore of Lake Michigan where the tempering influence of the lake favors the culture of many deciduous fruits. Some of the soils in this region are extremely sandy and are more particularly adapted to peach-growing than to apple-culture. A large portion of land, however, is a sandy clay loam, well suited to apples.

The region is known as the western Michigan fruit belt and extends from Berrien County on the south to Cheboygan County on the north. The most important apple counties of this region are Van Buren, Allegan, Kent, Berrien, Oceana and Grand Traverse. Apple plantings are also found in adjoining counties and widely scattered throughout most of the lower peninsula of Michigan. Some of the oldest orchards in the state are in the south and southeastern counties, but the importance of this region has given way to the newer plantings, particularly in the northern end of the western Michigan fruit belt.

Production for western Michigan in a full crop year would approximate 1,200,000 barrels or about 75 per cent of the total commercial apple production of the state of Michigan. The plantings in the southern part of the belt suffered severe loss from San José scale, while those in the northern part are much younger and have experienced less injury from scale. There has undoubtedly been a decline in the production in Michigan as compared with 1910.

However, with the young orchards just coming into bearing and with better care being given to the older trees, it seems highly probable that this loss will be made up within the next few years.

The leading variety grown in western Michigan is the Baldwin, which comprises over one-fourth of the total production. Northern Spy and Oldenburg (Duchess) each represents about 14 per cent of the total production. According to a recent survey, varieties next in order of importance are Wagener, Rhode Island Greening, Wealthy, Ben Davis, and Jonathan; the last named being prominent in the newer orchards of Van Buren, Allegan and Berrien counties. Ben Davis is outstanding in the older orchards in the southernmost counties. Oldenburg (Duchess) and Wealthy are the leading summer and fall varieties.

Most of the apples of this region are packed out in barrels and a large proportion of the crop is marketed in Chicago, Detroit, Milwaukee, and other large cities nearby. Producing communities situated close to cities market much of their apple crop by wagon or truck, crates and bushel baskets figuring in this movement. An increased interest in the apple industry in western Michigan is evidenced in better cultural and marketing methods. Coöperative associations are increasing in prominence in many localities.

ILLINOIS

Illinois occupies a position of considerable importance in the commercial production of apples. Soil conditions generally throughout the entire state are very well adapted to apple-growing, and nearly every county has a considerable acreage of trees.

Strictly commercial areas are largely confined to the southern part of the state. They may be segregated into three fairly well-defined regions: (1) The extreme southern portion; (2) the Mississippi Valley region centering about Pike and Calhoun counties; (3) the southeastern part of the state, centering in Marion County.

Illinois is probably under-estimated from a commercial standpoint. New orchards coming into bearing, and the renovation of old ones have combined in making this the most important middle western apple state. Its central location and proximity to market serve as distinct advantages.

Southern Illinois early apple region.

The extreme southern or early apple section in Illinois may be defined to include the eleven southernmost counties, but only Union and Johnson are of great commercial importance. These counties probably comprise one of the most important early apple-producing sections in the United States. J. C. B. Heaton of New Burnside is one of the persons largely responsible for the early development of this industry. Good returns for apples have stimulated planting and an increasing production may be expected from this region.

The principal early varieties are Yellow Transparent, Duchess of Oldenburg, Benoni, Red June, Chenango and Sops of Wine. Summer varieties comprise nearly three-fourths of the total production.

Prominent among winter varieties are Winesap, Ben Davis, Gano, Jonathan, and Rome Beauty. Early apples are shipped in baskets to Chicago, St. Louis and other nearby cities. The shipping season for these apples

begins the last week in June and is usually over by August first. Winter apples are sold either in bulk or in barrels.

In some ways this extreme southern portion of Illinois is a continuation of the Ozark uplift. The country is somewhat mountainous and unlike northern Illinois. The soil is rather thin and in general well suited for the quick early growth of summer varieties.

Mississippi Valley region of Illinois.

Adams, Pike and Calhoun counties bordering on the Mississippi River are responsible for the heavy production of apples in western Illinois. Calhoun leads in tonnage shipped and a large part of its output goes down the Mississippi River by boat.

Conditions are dissimilar to those in the early apple region in the southern part of the state. With the exception of Calhoun and Pike counties, land in western Illinois is more typical of the prairie states. Calhoun County apple production is being more than maintained by new plantings. While the total acreage in the other counties may have suffered more or less decrease from 1910 to 1918, a greater interest generally is exhibited among the leading and strictly commercial growers. Nearly 90 per cent of the acreage in this section is sprayed, while for the state as a whole it is doubtful whether 25 per cent of the acreage is sprayed.

Leading varieties for this region are Ben Davis, Gano, Jonathan, Grimes, Willow Twig and Winesap. Ben Davis and Willow Twig predominate. Practically all commercial apples are shipped in barrels.

Southeastern Illinois.

The Marion County district in southeast Illinois is sometimes spoken of as the Flora section, since Flora is the principal shipping point and one of the important apple centers in the state. Clay, Richland, Wayne, Effingham and Jasper counties are also included in this general region. Marion County was at one time credited as leading in the state in total number of trees, but in recent years has suffered heavily from loss in trees. Practically all of the orchards are of bearing age and very few trees are coming into bearing to replace a great percentage which passed out prior to 1918. Neglect, old age, and infection with disease and insects, notably San José scale, have exacted a heavy toll. Some commercial growers are maintaining their orchards, but it is doubtful whether over 50 per cent of the total acreage is sprayed at all. Yields throughout this section are generally low.

Most of the apples are sold in bulk; the remainder in barrels. Ben Davis is the leading commercial variety and represents over half of the total production. Jonathan, Winesap, Rome Beauty and Grimes Golden are less extensively grown. Of the summer varieties which probably represent 15 per cent of the total production, Benoni, Transparent, Duchess and Wealthy are important. Considered as a whole, Illinois is one of the few if not the only middle western state to maintain its commercial production in the face of a general decline in apple acreage throughout the Middle West during the period 1905 to 1918. Of its three commercial apple regions, two are showing increased production. High production is possible with good care and it seems probable that

Illinois will remain the leading apple state of the Middle West for some years to come.

OZARK REGION

The Ozark region in southern Missouri and northwestern Arkansas is one of the best known apple sections in the United States, although in production it ranks third among the four important Middle West districts.

Essentially it is a Ben Davis region, since this variety and Gano represent over 65 per cent of its plantings, and an even greater proportion of its production. During the decade 1890 to 1900, the entire Ozark region experienced an era of planting unequalled in any other section of the country. Prices for apples in the late eighties stimulated and encouraged plantings, and the good yields produced by the Ozark orchards then in bearing afforded excellent returns. The over-planting which occurred in the nineties resolved itself into somewhat of a land-selling boom, a repetition of which was experienced in the western states from 1900 to 1910. Thousands of acres of both suitable and unsuitable land throughout the Ozarks have been set to trees, but of this great acreage only a portion has been cared for and much has been neglected and abandoned. The Ozark region includes some of the best and some of the worst orchards in the country. A period of late spring frosts in 1900 to 1910, when a number of consecutive crops were lost or severely damaged, contributed to the lack of care accorded to many of these trees.

A full crop for the entire Ozark region would probably not exceed 1,600,000 barrels. Arkansas' contribution to the Ozark apple production originates almost entirely in

two counties, Benton and Washington, situated in the extreme northwestern part of the state. Madison, Boone, Carroll and Crawford counties in Arkansas are of much less importance. Bentonville and Rogers in Benton County, and Springdale and Lincoln in Washington County are important apple centers in Arkansas.

In Missouri the commercial apple plantings of the Ozarks continue from the extreme southwestern part of the state, along the Frisco Railway to the northeast as far as Crawford County. Lawrence, Greene, followed by Newton, Barry, Webster and Howell, are the most important Missouri counties in the Ozark region. Marionville in Lawrence County is the center of the best orchard section in southern Missouri. Orchards in the vicinity of this town illustrate the possibilities to be attained in the Ozark region.

Probably no other commercial apple district in the United States has suffered such a loss in trees as has the Ozark since 1910. Conservative estimates place the loss at more than 50 per cent, much of which has been due to blister-canker. With such conditions prevailing, one is not surprised in finding two very divergent types of orchards. There are the old, neglected dying orchards which have received practically no care while in some communities a revival of interest has brought many orchards into a high state of cultivation and profitable bearing. In such counties as Texas in the extreme southern part of Missouri are orchards which look almost like virgin forests, branches interlock, trees are unsprayed, unpruned and uncared for. The price of the land is established by its value for general crops, less the cost of removing the neglected trees.

Orchards in the Ozark region vary from a few acres to over 100 in size, many of them being from 30 to 100 acres in extent. Large orchards discourage intensive cultural methods and yields tend to be low and biennial as trees grow older. In some localities there is a progressive element in the farming population, evidenced by greater attention given to orchard management. Despite this revival of interest it is doubtful whether over 35 per cent of the trees in the Ozark region are ever sprayed, with a result that not more than 35 per cent of the total acreage can be considered as strictly commercial.

As stated above, Ben Davis and Gano represent over 65 per cent of the Ozark production. Jonathan, Ingram, Maiden Blush, Grimes, York Imperial, Collins and Arkansas Black are found in limited plantings, more particularly in younger acreage.

More than half of the production from this region is shipped in bulk, only the better grades and the higher quality varieties being shipped in barrels. It must be remembered, however, that the bulk production competes directly with the barreled stock and is frequently not inferior in quality.

MISSOURI RIVER REGION (PLATE III)

Important commercial apple plantings of Iowa, Nebraska, Kansas and northern Missouri are at the intersection of these four states, in what is known as the Loess Apple Belt, along the Missouri River in northwestern Missouri, southwestern Iowa, southeastern Nebraska, and northeastern Kansas. This section has been placed in a district by itself, since the important

plantings are centralized in a well known and fairly well defined commercial region.

The most extensive apple plantings in the Missouri River region are in Buchanan County in the vicinity of St. Joseph in northwestern Missouri, and across the Missouri River in Doniphan County in northeastern Kansas. Iowa and Nebraska plantings are of less importance although the Missouri River region properly includes small corners of the above two states. In Nebraska, Nemaha and Richardson are two important counties, while across the Missouri River, Fremont, Mills and Pottawatomie counties lead in the commercial production for Iowa.

All of the counties named border on the Missouri River and with several other counties in close proximity, comprise a fairly compact region which extends into four states and has a normal production of nearly 2,000,000 barrels, which is greater than can be credited to the Ozark region. Ben Davis and Gano comprise approximately 50 per cent of the production from the Missouri River district, while Jonathan, Winesap, Arkansas (Black Twig) and Missouri Pippin trees have been extensively planted, particularly in the younger orchards. A large part of the crop moves out in bulk as is the case in the Ozarks.

Doniphan County, Kansas, deserves particular mention as one of the most important and highly commercial counties in the Middle West. Community spirit has stimulated development of the apple industry and extensive plantings are found in the vicinity of Wathena and Troy. A high percentage of the yield of Doniphan County is barreled and more of the trees are sprayed than in probably any other middle western apple section. Carload shipments from Doniphan County alone have amounted

to more than 1,000 cars for a single season. In most instances the orchards reflect the careful attention which always insures a high state of productiveness.

Orchards in northwest Missouri are older, have a larger proportion of Ben Davis trees and in the main have received less attention than those on the Kansas side. Buchanan County on the Missouri River ranks among the foremost, if not the foremost apple county in Missouri, and yet it is doubtful whether 50 per cent of the trees are sprayed. While Buchanan County has been singled out on account of its central location and relative importance, other counties in northwest Missouri, including Nodaway, Holt, Jackson and Lafayette, are of almost equal importance.

The orchards in the Missouri River region are more uniform in type than those in the Ozarks and are, as a whole, better cared for. There are many old neglected orchards in northwest Missouri, but these are fast going out and the production from strictly commercial orchards promises to dominate the output of the region. The greatest increase in production may be expected from the young plantings in Kansas, many of which are just coming into bearing.

Outside of the intensive commercial apple regions, the Middle West has suffered a tremendous loss in trees. However, most of these were in the farm orchards and it is felt that such regions as the Missouri River or loess soil region will serve to maintain the commercial production of the Middle West at some point near its present figure. It must be remembered that apple-growing along the Missouri River has never reached the intensity of many other regions. General farming with here and there a

PLATE IV.— Looking across the floor of the Wenatchee Valley at Cashmere, Washington.

commercial orchard describes the general farm management scheme. As may be expected, where apple-growing is only one of a number of enterprises, the general care given orchards is not as highly intensive as in some sections. Commercial production at the present time comes from a comparatively few well-cared-for orchards.

ARKANSAS VALLEY OF KANSAS

The Arkansas River Valley in south central Kansas is a distinct region which requires separate treatment. Apple plantings in this valley are confined largely to the sandy loam soil along the river and are in Reno, Sedgwick, Sumner and Cowley counties. Not all the valley land is suited to apples and plantings are spotted. Many of the orchards are irrigated with water pumped from wells and it is the only section east of Colorado in which irrigation is practiced in the growing of apples.

Heavy plantings were made in the period 1907 to 1910 and this region will be of increasing importance as trees attain full bearing. Winesap and Ben Davis are the leading varieties, while Jonathan, Black Twig, Gano, York Imperial, Grimes and Rome Beauty are of less importance. On account of irrigation and other farm management practices in vogue, the Arkansas Valley has more in common with the western irrigated districts than with the typical Middle West sections. Furthermore, while bulk shipments represent a large portion of the crop, a considerable percentage of the output is marketed in boxes. No barreling is done. A full crop from this region would be equivalent to about 250,000 barrels at present. Increased production may be expected.

COLORADO

Colorado stands out prominently as the most important apple state in the inter-mountain district. Practically the entire commercial apple crop of Colorado is produced on the western slope of the Rockies, in the Grand and Gunnison valleys. The Grand Valley, extending in either direction from Grand Junction, in Mesa County, for a distance of about twelve miles, is the most highly developed district in the state. This valley is comparable in many ways with typical northwest apple districts, being essentially boxed apple-producing, relying on irrigation, and employing northwest methods of culture and farm management.

Heaviest planting in the Grand Valley was in the period 1905–1910. Practically no planting occurred between 1912 and 1918. In 1918 there were about 10,250 acres of apples, of which 7,500 were over ten years of age. Alkali outcroppings in certain parts of the valley caused a considerable loss in acreage, amounting to probably 2,000 or 3,000 acres. It is possible that further decreases in acreage will occur and yet increased bearing capacity of the remaining acreage will doubtless bring about increased production. The principal shipping stations in Mesa County are Grand Junction, Fruita and Clifton.

The Grand Valley, while primarily an apple section, is not exclusively apple-producing. Nearly half of its fruit acreage consists of other fruits than apples. Peach and pear plantings, with smaller acreages of cherries and plums, represent in the aggregate nearly as extensive acreage as the apple. In the vicinity of Palisades, some

ten miles from Grand Junction, is the famous Elberta peach section, which has shipped 1,000 cars of peaches in a single season.

The Grand Valley did not escape inflation. In fact, difficulties with irrigation systems and outcropping of alkali have brought this district its full share of troubles. In recent years the codlin-moth has become a most serious menace. In one respect, however, notably proximity to markets, Colorado has the advantage of states farther west. It is particularly adapted to the growing of Jonathan apples, which comprise nearly a third of its production. Winesap, Gano, Ben Davis, Missouri Pippin, and Rome Beauty are among the other important varieties. The northwest box is used almost exclusively for the packed fruit, although bulk shipments figure more prominently in Colorado than in any other of the leading western apple states. Coöperative marketing has been an important factor in the development of this district.

The western slope of Colorado includes two other apple districts, one in Delta and the other in Montrose County, both of less importance than the Grand Valley. In Delta County the apple acreage is in Gunnison Valley, with heaviest plantings at Hotchkiss and Paonia. The Uncompahgre, a branch of the Gunnison, supplies water for the orchard plantings in Montrose County which centers about the town of Montrose. Both of these districts are irrigated and conditions conform largely to those given for the Grand Valley. Varieties are very much the same, although less attention is given to other fruits.

On the eastern slope, the Canyon City district in Fremont County, along the Arkansas Valley, is the only other apple section of importance in the state. A distinctive

feature of Colorado commercial apple plantings is that they occur at an elevation of 4,000 to 5,000 feet above sea level.

NEW MEXICO

The Pecos Valley in Chaves County is the coming apple district in New Mexico, and is one of the important sections of the inter-mountain states. Over half of New Mexico's commercial apple crop is produced in Chaves County. Heaviest plantings are in the vicinity of Roswell, Greenfield, Dexter and Hagerman. The latter lies thirty miles south of Roswell along the Pecos River. County assessor's figures indicate about 4,500 acres of trees planted before 1910 and about 2,500 acres planted 1910 to 1919. Little planting has been made since 1912.

Ben Davis and Gano are the principal varieties, with Missouri Pippin, Jonathan, Winesap, Black Twig, York Imperial and Arkansas Black among the less important.

The northwest box is the common package for this district, although bulk shipments are important. Less care is taken in grading and packing the boxed fruit than in the Northwest and much of the crop is jumble packed. The Texas farming section immediately to the east affords an outlet for most of the Pecos apple crop. Jonathans come on the market earlier than in most sections, and for that reason Pecos apples have priority in Texas markets. A marked increase in production may be expected from this section. Heavy frosts are not infrequent and have checked the normal increase in production. While 600 or 700 cars has been the largest production of this valley to date, a decided increase may be expected.

The only distinct apple region in New Mexico outside of the Pecos Valley is known as the Farmington district and is in San Juan County in the extreme northwestern corner of the state. The isolation of this region, combined with poor railroad facilities, has checked its development. Principal varieties are Gano, Jonathan, Rome Beauty and Winesap.

UTAH

Commercial apple-growing in Utah is largely confined to irrigated valleys in Boxelder, Weber, Davis, Salt Lake, and Utah counties, which lie along the eastern shores of the Great Salt Lake and Utah Lake, in north central Utah. The most highly commercial districts are near Provo in Utah, which has shipped as high as 300 cars of apples in a year, and also near Tremonton in Boxelder County. Both are irrigated and market their commercial apples largely in boxes, although bulk shipments are not uncommon.

Principal varieties for the Provo district are Jonathan, Rome Beauty, Winesap, and Lawver; for the Tremonton section Ben Davis, Gano, Jonathan and Winesap. The apple acreage in Utah County is approximately 5,000 acres, of which two-thirds was planted before 1910. Of the 2,000 acres in apples in Boxelder County, most of the trees were planted between 1906 and 1910. Local consumption and nearby mining camps largely absorb the production of Weber and Davis counties. Limited increase in commercial production may be expected from this state as the acreage increases in age. It is improbable that commercial shipments will exceed 1,000 cars within the next few years.

MONTANA

The Bitter Root Valley, extending south from Missoula to Hamilton, Montana, at one time had an apple acreage amounting to 23,000 acres. Most of this acreage was represented in large projects which have since gone into the hands of receivers and are being neglected. Probably the greatest loss in acreage in any of the western districts has occurred in the Bitter Root Valley. The McIntosh apple is suited to this region but trees do not attain large size nor is growth rapid. Yields are smaller than in many other irrigated sections. The slump in apple promotion struck the Bitter Root Valley at an inopportune time, and as a result much of its acreage will be lost or will not reach full commercial bearing.

WASHINGTON

Interest in apple production west of the Rockies centers chiefly in the Pacific Northwest and particularly in the state of Washington. In 1917 and 1919 Washington was the heaviest commercial apple-producing state in the Union, taking precedence even over New York which, on account of exceedingly light crops, dropped into second place for those years. Washington must be credited with over one-half of the total boxed apple production and in an average year now ranks first in quantity of commercial apples produced.

It is interesting to note the very rapid growth and development of the apple industry in such regions as the Yakima and Wenatchee valleys, which have recently come into prominence and are largely responsible for Washington's heavy production. Although very similar in many

respects, these two districts will be discussed separately on account of their importance.

Yakima Valley.

The Yakima district is located in the south central part of the state and includes approximately 40,000 acres of apple plantings which are for the most part situated in the valley land lying along the Yakima River and its tributary streams.

As stated in the history of the Yakima district, the first commercial planting was made in this region about 1888 and as late as 1900 the total acreage of all orchard land was not more than 3,000 acres, and the total production did not exceed 200 carloads of fruit. Heaviest planting occurred after 1900 and reached a climax about 1908.

Apple-growing is the principal industry in the Yakima Valley and, as might be expected, intensive methods of cultivation are practiced, every effort being directed at the production of high marketable quality fruit. The average fruit farm is under twenty acres and is devoted almost exclusively to apples. Peaches and pears are grown in lesser quantities and represent approximately 12 per cent of the total fruit acreage of the county. In more recent years greater diversification has been emphasized, with the result that growers with larger acreages are planting sugar-beets, potatoes and other crops.

The productivity and ideal climatic conditions of the Yakima Valley attracted an unusually high type of settlers. The community spirit and social conditions are unsurpassed by those in any other apple region. Good roads have been constructed and excellent facilities for handling, packing and storing the fruit are available. Probably

nowhere else in the country have scientific horticultural methods been more assiduously practiced than in the Yakima Valley.

The productivity of the Yakima orchards is very high. Their annual yields are greater than those in any other region with the exception of the Wenatchee district.

The average annual rainfall in the Yakima Valley is under twelve inches, and irrigation is necessary. Millions of dollars have been expended in irrigation projects designed to bring water from the mountain streams and fructify the otherwise desert land. A large part of the acreage is watered from canals operated under the United States Reclamation Service, although private projects are also found. Water rights in some instances have cost as high as $175.00 an acre; the average has been much lower, however. Annual maintenance of the irrigation ditches once installed often represents as much as $4.00 an acre. When to these costs are added the high price for raw land and the expense of bringing an orchard into bearing under the most intensive care, some idea may be obtained of the reason for high valuation of western irrigated orchards. Two thousand dollars an acre has not been an uncommon price for full bearing orchards. In some instances unsuited land was planted and the district suffered from over-development of " boom " projects.

The Yakima Valley is under a severe handicap by its distance from consuming centers. It must rely on large annual yields of high marketable apples for its survival. Production has been rapidly increasing and reached 11,500 cars in 1919. Less than 25 per cent of the acreage was over ten years of age in 1918 and an increased production may be expected from this region in the next few years.

Winesap is the leading variety and in some years represents as high as one-half of the total production. Heavy plantings have been made of Jonathan, Ben Davis, Rome Beauty, Esopus (Spitzenburg), Yellow Newtown, Delicious, Stayman, Gano and lesser plantings of Arkansas (Black Twig), Baldwin, Wagener, Grimes Golden and Arkansas Black. Probably in no other region is there a larger list of extensively grown varieties and yet most of those named are good commercial kinds well adapted to the region.

Wenatchee North Central Washington district (*Plate IV*).

The Wenatchee Valley is included in what is commonly spoken of as the North Central Washington fruit region. Although less than fifty miles apart, the Yakima and Wenatchee valleys are separated by a range of mountains and there are no rail connections except by a very circuitous route. These two very important fruit regions have grown up almost simultaneously under very similar conditions, vieing with each other in the production of high marketable quality apples.

The Wenatchee Valley proper is in Chelan County, although in speaking of the North Central Washington district one commonly includes apple plantings along the Columbia River and its tributaries, extending northward from Wenatchee into Okanogan County. Annual rainfall varies from eight to fifteen inches and irrigation is necessary.

The principal producing area of this region lies in the Wenatchee Valley in the vicinity of the towns of Wenatchee, Monitor and Cashmere, and extends as far up the valley as Leavenworth, the latter being situated at the

base of the Cascades. A very intensive region is in a semi-circular area about the town of Wenatchee. There is a considerable variation of altitude throughout the valley, but most of the orchards are at an elevation of 700 to 1,000 feet.

The Wenatchee Valley is even more intensive and compact than the Yakima Valley. Its development dates back to about 1900, when the first large irrigation canal, later known as the Wenatchee Highline Canal, was begun. The planting of fruit-trees was more or less correlated with the development of irrigation. The total apple acreage in North Central Washington, including the Wenatchee Valley and the upper Columbia, is approximately 40,000 acres. Some of this acreage is in Okanogan, Douglas and Grant counties adjoining Chelan County on the east. The shipments reached a maximum in 1919–1920 of 12,300 cars of 756 boxes each.

The farms in general throughout the Wenatchee region are small, most of them averaging not over fifteen acres and many even less. Some large projects embrace as many as several hundred acres each, but the region is not adapted to the extensive type of agriculture. The two predominating limiting factors are the high price of land and the small area of irrigable land. Peaches and pears are grown in limited quantities and there is also a considerable acreage of alfalfa, but most of the latter occurs as an inter- or shade crop in the apple orchards.

An intensive survey made by the authors in the Wenatchee Valley indicated an average investment to the acre of nearly $2,000. It may be seen that with such a high valuation only a highly specialized crop like apples can ever be made to bring a sufficient return on the invest-

ment. It seems, then, that the Wenatchee Valley offers less opportunity for diversification than almost any other region in the United States. At the same time it is unsurpassed in productivity and high marketable quality of its fruit. The surveys indicate that of all the apple regions of this country the highest annual yields and the highest percentage of extra fancy and fancy fruit were produced in the Wenatchee Valley. Like the Yakima Valley, the Wenatchee district must rely on heavy yields and high marketable quality fruit to overcome a severe handicap of extreme distance from markets. The possibility for coöperative movement among growers is explained by the intensity of plantings and by excellent community spirit.

As in Yakima, the most intensive and careful orchard practices are in use. The Wenatchee region is practically free from fungus trouble, and with the exception of the codlin-moth, which is a decided menace, is infested with but few serious insect pests. In their early development, the Wenatchee orchards were almost without exception committed to a practice of entire clean cultivation, without either shade or cover-crops. More recently, as in all irrigated districts, the use of leguminous shade crops has become common.

The highest production from the Wenatchee North Central Washington district prior to 1919 was the crop of 1917 which amounted to approximately 8,500 cars of 756 boxes each. At least 75 per cent of the acreage was under ten years of age in 1918 and an increased production from this region may be expected. Winesap, Jonathan, Delicious, Spitzenburg, Stayman, Rome and Yellow Newtown are listed in the order of their importance.

Spokane district.

The third most important apple district in Washington is in Spokane County and is commonly spoken of as the Spokane apple district. Acreage of this county at one time was nearly as great as that in Yakima, but the production has never approached that of the latter. The region was developed after the Yakima and Wenatchee districts and considerable acreage of unsuited land was set in trees. The most intensive plantings are in the Spokane Valley west of Spokane, extending along the river for a distance of twenty-five miles to the east. Production from the county reached about 1,400 cars in 1920. A considerable increase in production may be expected, although it seems probable that much of the acreage originally set to trees, and particularly the trees on non-irrigated land, will never attain full commercial bearing. The principal varieties are Jonathan, Rome Beauty and Wagener.

Walla Walla district.

The Walla Walla district is the fourth important section in Washington. It is largely an upland region of rolling hills. Irrigation is not generally practiced. The production has reached 1,000 cars in a single season. Much of the acreage is not yet in full bearing and increasingly large crops may be anticipated.

OREGON (PLATES III, V)

Hood River Valley.

Oregon apples have come into prominence largely through the production from the very well known Hood

PLATE V.— View of the Hood River Valley fruit section. Most of the Hood River orchards are visible in the picture.

River Valley, which stands out pre-eminently as the principal apple-producing region in Oregon, and which must be credited with approximately half of the state's commercial production. In many ways the Hood River Valley is not comparable with the other western irrigated regions. Instead of a dry arid climate, it has a rainfall equaling that of New York. The trees have a different habit of growth and lower average yields are obtained than in most other apple sections of the Northwest. Lighter yields are very largely accounted for by the fact that Yellow Newtown and Esopus (Spitzenburg), well known as high quality but rather shy bearing varieties, predominate.

The development of the Hood River Valley occurred simultaneously with, or slightly in advance of, that of the Wenatchee and Yakima valleys. The Hood River district lies almost entirely in Hood River County, the latter being situated on the Columbia River at the northern boundary of the state. The valley is narrow, varying from two to eight miles in width, and the cultivated area extends from the town of Hood River, south to Parkdale in the upper valley, a distance of about twenty-four miles. This region is divided into what are known locally as the lower, middle and upper valleys. The lower valley contains the most bearing fruit and the greater percentage of tillable land.

The Hood River, a fast flowing mountain stream rising at the foot of Mount Hood, divides the valley into the east and west sides. The orchards are located on the benches and rolling land on either side. For the most part, the orchards are small and receive the same cultural treatment which prevails in the Wenatchee and Yakima districts. Irrigation, although not always necessary, has been found

advisable in the growing of cover-crops and is common among most of the orchards.

Many persons were attracted by the unusual scenic beauty of this little valley, which lies at the foot of Mount Hood. Unfortunately Hood River did not escape the effects of inflated land values and growers experienced a period of depression for a few years prior to 1917. The region has become widely advertised and known, although its production has never exceeded 2,200,000 boxes and will never approach in quantity that of the Yakima and Wenatchee valleys. Coöperative marketing has featured in the development of this region and the output of the valley commands unusually high prices. As stated above, the production in this region is largely confined to two varieties, the Yellow Newtown and the Esopus (Spitzenburg).

Rogue River Valley.

The Rogue River Valley, although now widely known as a pear section, is the second largest apple-producing region in Oregon. The valley is somewhat highly specialized, although its development has been slower than in most other apple districts in the Northwest. Land values at one time were very high and a large number of easterners were attracted to the valley. A period of drought years, during which the annual rainfall dropped from the normal twenty-two inches to as low as twelve inches, caused great loss and emphasized the need of irrigation, which is now practiced in about a third of the orchards and is being extended to the others.

The fruit acreage lies almost wholly in Jackson County and plantings are centralized in Stewart Creek and Rogue

River valleys, about the towns of Medford, Ashland, Talent and Phoenix. Of the approximate acreage of 23,000 acres of commercial fruit plantings, about 13,000 acres are in pears and 10,000 in apple trees. In the apple acreage, Yellow Newtowns, Esopus (Spitzenburg), Jonathan, and Ben Davis are the predominating varieties. Probably 75 per cent of the present production consists of Yellow Newtowns. As in other northwest districts, the summer apple is an almost negligible factor. Approximately half of the apple acreage of this region was ten years of age or over in 1918.

The prevalence of spring frost-injury led to a rather wide use of oil-heaters, particularly in the orchards on the floor of the valley. Foothill orchards are less subject to frost and as a rule are not smudged. Despite the dry atmosphere, the apple-scab is more or less prevalent and requires summer spraying. Fire-blight, particularly among the pear trees and Esopus (Spitzenburg) apple trees, caused great loss in the years 1913–1915.

The droughts between 1914 and 1918 checked the normal increase in production. The largest crop of apples prior to 1919 was harvested in 1917 and consisted of about 700 cars. Practically all of the marketable apples are packed out in boxes.

Other apple districts in Oregon.

In addition to the apple plantings in the Hood and Rogue River valleys are some very promising apple orchards in the Willamette Valley and Roseburg section; and also in the Milton-Freewater district in the northeastern part of the state. Commercial projects are also found in Wasco County.

IDAHO

The following four fairly well defined, yet more or less isolated, apple sections are found in Idaho: Payette Valley, Boise Valley, Lewiston district and Twin Falls district. Idaho was somewhat behind Oregon and Washington in the time of the development of its fruit industry and probably has a greater proportion of young trees than either of the other two. The commercial production of Idaho exceeded 3,600 cars in 1919.

Payette district.

The apple acreage of the Payette district is largely in the Payette Valley, with extensive plantings in the vicinity of Fruitland, Payette, Weiser and New Plymouth. This district represents the heaviest producing area in the state. Its production has exceeded 2,000 cars in a single season and an even greater output is promised on account of the new acreages just coming into bearing.

As in all of Idaho's plantings, the Jonathan grows to perfection and is the predominating variety. Other important varieties of the Payette are Rome Beauty, Gano, Ben Davis, and Winesap. The northwest box system of packing and general orchard management is used throughout this region, although there is not the intensity of cultural methods, nor quite the high state of specialization, as in the Yakima and Wenatchee districts. Severe frost-injury has destroyed the crop in certain years and frost liability has somewhat deterred the development of the region. The Payette district was known as a hay and stock raising country long before an impetus was given to its apple industry. Although the orchards are small, con-

siderable fertile land unplanted to trees offers opportunity for diversification.

Boise Valley.

Much the same conditions obtain in the Boise Valley as in the Payette district, these two sections being only a few miles apart and having been developed under much the same conditions. Plantings in the Boise Valley are much more limited than in the Payette district.

Twin Falls.

In the extreme southern part of Idaho and in the vicinity of Twin Falls is an irrigated region which has intensive apple plantings, amounting to 4,000 or 5,000 acres, most of which have not attained full bearing and considerable of which have been taken out to provide for more general farming. The production in 1919 reached approximately 500 cars and the output of the region may be expected to increase. Varieties and general orchard conditions are much the same as in the Payette district.

Lewiston section.

Near Lewiston in Nez Perce County, an irrigated project of 6,000 acres was planted largely in the period 1906 to 1910. This was developed by a single company and was sold out in small tracts to investors who in some instances have taken up their residence and are developing the subdivisions. Very few orchards have reached full bearing, and although they were planted and have been cared for on a strictly commercial basis, the future of the region can not be definitely determined at this time.

CALIFORNIA

Watsonville district.

The Pajaro Valley, centering about Watsonville, is the oldest and from the standpoint of total past production, one of the most important of the western apple regions. In later years, however, both the Yakima and Wenatchee valleys of Washington have far outstripped it in production. With the possible exception of the Wenatchee Valley, it is doubtful whether any apple region in the country exceeds the Watsonville district for intensity of planting. The most important orchards are included in an area of five by ten miles about the town of Watsonville. This limited area is responsible for nearly two-thirds of California's commercial apple crop, and has a production record of almost 3,300,000 boxes of apples for a single season.

Apple plantings were known to have been made in the Pajaro Valley in the early fifties. Commercial orchards existed as early as 1870. The period of greatest commercial growth occurred in the decade 1890–1900. Crop failures are uncommon in the Pajaro and this valley has a very high record for annual production. Irrigation is little practiced, the normal annual rainfall of forty inches being sufficient to insure heavy annual production. Yellow Newtown is the leading variety and comprises over 50 per cent of the regional production. Yellow Bellflower is next in importance while both Red and White Winter Pearmain, Langford Seedling and Missouri Pippin are grown in limited quantities. Red varieties, however, are not adapted to this region.

A most peculiar system of handling the crop prevails

in the Watsonville section. A large colony of Slavonians has for many years been closely identified with the industry in the buying and packing of apples. A large percentage of the growers sell the fruit on the trees for a lump sum to these Slavonian packers, who care for the orchard, do such spraying, thinning and propping as is practiced, later harvesting and packing the fruit. Seasonal contracts are very often made at blooming time, although some growers contract their crops for a period of several years in advance. The speculative side of such transactions need not be emphasized. Disastrous crop failures may mean ruin for the buyer, while high prices very often mean large profits. The Slavonians assume the growers' risk and naturally require a margin commensurate with the risk.

Despite many natural advantages, the Watsonville district has been slow to adopt high standards for the grade and pack of its fruit, and as a result it has not kept pace with northwest production in this respect. Coöperative handling and marketing has been developed to a limited extent among the progressive growers. Until recently, the California box (9½ x 11 x 22), a slightly larger and longer box than that used in the Northwest, has been in most common use, as has also the straight line pack instead of the northwest diagonal pack. More recently a state law has sought to make the northwest box the standard. Export trade normally absorbs a large portion of the Yellow Newtown production. The Yellow Bellflowers are largely sold in domestic markets, many in California.

Sebastopol apple district.

The Sebastopol apple district is considerably less important than the Pajaro Valley or Watsonville section and yet it is the second region in California. The most extensive plantings are in the vicinity of Sebastopol which is situated in Sonoma County about sixty miles north of San Francisco. This is the only distinctive early apple section in the West and has come to prominence largely through its production of Gravensteins.

In normal years the shipments of fresh apples from this region seldom have exceeded 600 cars and most of these have been Gravensteins. The apple plantings are much more recent than those near Watsonville and an increased production may be expected. Sebastopol deserves mention as a dried apple center. In normal years more of its crop is dried than is shipped fresh. This section has produced as high as 2,000 tons of dried apples in a season. Among the winter varieties, Esopus (Spitzenburg), Baldwin, Yellow Newtown, Yellow Bellflower, and Rome Beauty are more or less prominent. A large part of the production of the latter varieties is dried.

There is little similarity between the type and character of the Sebastopol orchards and those of the more important Watsonville section. In the former, the orchards conform more to the mountain type and are of almost entirely different varieties than at Watsonville. Irrigation is not practiced.

Yucaipa section.

A third apple region has more recently developed in California in San Bernardino and Riverside counties in

the extreme southern part of the state. The Yucaipa section, as it is known, consists largely of young more or less mountain plantings which, although limited in extent, are somewhat intensively cared for and will doubtless be responsible for an increasingly large production. Already this region has shipped as many as 200,000 boxes of apples in a season.

TABLE III.— AVERAGE PRODUCTION OF THE LEADING APPLE DISTRICTS OF THE WEST

Districts.	Average Production 1916–1919. Packed Boxes.
Wenatchee, Wash.	6,686,675
Yakima, Wash.	6,015,250
Watsonville, Cal.	2,787,500
South Idaho	1,894,750
Western slope Colorado	1,492,500
Hood River, Ore.	1,625,000

WISCONSIN

Apples are grown largely in home orchards, most of which are distributed throughout the southeastern part of the state and particularly in the counties bordering Lake Michigan. Taking the state as a whole, Fameuse, McIntosh, Oldenburg, Northwestern Greening, and Wealthy are the principal varieties. Harvesting period is somewhat later there than in some states.

There are three limited commercial areas in the state: (1) The Sturgeon Bay district in Door County on Lake Michigan, in which heaviest plantings are about Sturgeon Bay, Egg Harbor, and Ephraim on the west shore of the peninsula; (2) limited plantings, chiefly about Richland Center in Richland County, Gays Mills in Crawford County and Baraboo in Sauk County in the southwestern

part of the state; (3) Eau Claire district in which limited plantings are found in Eau Claire, Chippewa, and Trempealeau counties. Duchess of Oldenburg and Wealthy are the leading varieties.

MINNESOTA

Minnesota is even less important commercially than Wisconsin, although there are many scattering home orchards through the south and particularly southeastern part of the state. In the vicinity of Lake Minnetonka, Long Lake and Howard Lake, in Hennepin, Meeker and Wright counties, are commercial plantings in which Wealthy, Patten's Greening, Hibernal, and the following crabs are grown: Florence, Whitney, and Lyman's Prolific. Some of these apples are jumble packed in boxes and others shipped in baskets. Another very limited commercial area is in Houston and Winona counties, in the extreme southeastern part of the state. In addition to the varieties named above, Wealthy, Northwestern Greening, and Wolf River are common for Minnesota. Crabs are widely grown.

EARLY APPLE REGIONS

Only a few counties in the United States produce early apples in quantity for commercial purposes. Early apples are grown to a greater or less extent in nearly all important apple regions and in nearly every farm orchard. By far the larger part of this production, however, is not strictly commercial, but is used only for local or home consumption. In this discussion particular attention will be given to the few specialized early apple regions.

New York and New England.

Although New York is not commonly considered a specialized early apple region, there is a heavy production of such varieties as Oldenburg (Duchess), Twenty Ounce and Wealthy in the western part of the state. Alexander and Yellow Transparent are grown in more limited quantities. The plantings of Oldenburg (Duchess) and Wealthy are found particularly in Niagara County while Twenty Ounce is grown extensively in Monroe County, about the town of Hilton. Scattered plantings of Wealthy, Gravenstein, Oldenburg (Duchess), and Williams Early Red are grown in the Hudson Valley, particularly near the Hudson River in Dutchess, Columbia, Ulster, and Greene counties. Very few apples are moved out of New York prior to August 1st. With a good crop, however, New York has shipped as many as 300,000 barrels of commercial early apples prior to September 15th, most of which originated in western New York.

Early apple varieties for New England are largely the same as those given for the Hudson Valley, the most extensive plantings being in Worcester, Middlesex and Franklin counties of Massachusetts.

New Jersey.

New Jersey, and particularly Monmouth County, has long been known as one of the most intensive early apple regions. Important early varieties for Monmouth County are English Codling, Oldenburg (Duchess), Wealthy, Gravenstein, Red Astrachan and Twenty Ounce. New Jersey has still another intensive and even more important early

apple district which includes the counties of Burlington, Camden, Gloucester and Cumberland in the southwestern part of the state. The most intensive plantings of this region are about the towns of Moorestown, Riverton and Burlington, not far from Philadelphia. The leading varieties are Starr, Williams Early Red, Yellow Transparent and Wealthy, with lesser quantities of Red Astrachan, Oldenburg (Duchess), and Early Ripe.

New Jersey as a whole is one of the leading early apple states of the Union. Its commercial production comes largely from the two regions described and has amounted to the equivalent of approximately 200,000 barrels in a good crop year.

Delaware.

Delaware is the most intensive early apple state in this country and at the present time 150,000 barrels of early apples would not be an excessive crop for the state as a whole. The most intensive plantings are in Kent and Sussex counties, about the towns of Wyoming, Bridgeville and Seaford. Yellow Transparent, Williams Early Red, Wealthy and Early Ripe are leading varieties. Twenty Ounce, Red Astrachan and Oldenburg (Duchess) are grown to a more limited extent. The early apple industry in Delaware is showing a marked growth at present. It is the only important region outside of New Jersey and southern Illinois which is able to put its fruit on the market in any great quantity prior to August first. The favorite method of marketing the fruit is in 5/8-bushel baskets. The Delaware early apple district extends into the eastern shore of Maryland.

Southern and Middle Atlantic states.

Yellow Transparent is the leading variety in the more southern districts. Early apple plantings, however, are more or less scattered and limited in extent. The production of Yellow Transparent in the vicinity of Bowling Green, Kentucky, and central Tennessee is increasing.

East North Central states.

Along the north side of the Ohio River in Ohio and Indiana are considerable plantings of early varieties, particularly of Oldenburg (Duchess) and Yellow Transparent. Large commercial plantings of the latter variety are also found in central Ohio.

In Michigan and Wisconsin the Oldenburg (Duchess) and Wealthy are prominent varieties. Their maturity, however, is greatly delayed in these regions with the result that they enter the market too late to be classed as distinctly early varieties.

Southern Illinois.

One of the most intensive early apple regions in the country is in the extreme southern part of Illinois. Union and Johnson are the leading counties and include extensive plantings of Benoni, Yellow Transparent, Oldenburg (Duchess), Sops of Wine, Red June, Chenango, and Cornell Red Streak. This region has produced as many as 800 cars of early apples in a season. Production is likely to increase.

California.

Scattered plantings of early apples are found throughout

the western states, but they are relatively limited and unimportant commercially with the exception of the Sebastopol region of Sonoma County, California. This region has become well known through its production of Gravensteins, shipping over 500 cars of this variety in a single season.

CHAPTER III

COMMERCIAL APPLE PRODUCTION IN CANADA, AUSTRALIA AND NEW ZEALAND

UNITED STATES is far ahead of any other country in the production of commercial apples. Only in some of the British Dominions has apple-growing attained commercial proportions on an organized scale. England, France, Germany, Russia and many parts of Europe have enormous numbers of apple trees but most of the fruit does not enter the world market, and in France nearly 90 per cent of the crop is used for cider or beverage purposes. Europe depends on United States, Canada, Australia and New Zealand for its supply of high grade fruit. South Africa is developing commercial apple-growing but as yet the production is not a factor in the world's markets.

CANADA

Canada at present (1920) will normally produce from 18 to 20 per cent as many commercial apples as the United States. The last decennial census (1911) credited Canada with 16,217,176 trees, about 60 per cent of which were then bearing. Apples are grown commercially in British Columbia, Ontario, Nova Scotia, Quebec, New Brunswick and Prince Edward Island, but the principal commercial sections are in the first three provinces. The commercial

crop in 1912 was estimated at 5,000,000 barrels. An estimate of 3,568,000 barrels was made for 1918, of which British Columbia produced 459,300, Nova Scotia 808,600, Quebec and New Brunswick perhaps 100,000, leaving Ontario with an estimated production of 2,200,000 barrels. In 1919, the Canadian crop amounted to 1,500,000 barrels in Nova Scotia alone.

The exports of apples from Canada for the past eleven years have been as follows:

Table IV.— Apple Exports from Canada

1909	1,604,477
1910	523,658
1911	1,664,165
1912	1,324,769
1913	947,382
1914	1,117,336
1915	557,451
1916	570,854
1917	103,626
1918	405,058
1919	591,805

For the five years from 1909 to 1913, the average export was 1,212,000 barrels, while the average for the years 1914 to 1918 was only 510,865. This, of course, is partly due to the British embargo on apples in 1917. About 90 per cent of the Canadian exports are to Great Britain under ordinary circumstances.

Nova Scotia (Plate VI).

The commercial apple-growing district embraces a comparatively small area, roughly described as the Annapolis Valley, about one hundred miles long and from six to eleven miles wide. The principal apple-growing counties are Kings, Annapolis and Hants, which produce about 75 per

cent of the total crop. The commercial production in Nova Scotia for the years 1911 to 1919 inclusive, together with the exports, are as follows:

TABLE V.—PRODUCTION AND EXPORTS OF APPLES IN NOVA SCOTIA

Year.	Commercial Production. (Bbls.)	Exports. (Bbls.)
1911	1,734,876	1,408,700
1912	993,523	801,000
1913	651,390	519,582
1914	981,437	752,500
1915	613,882	416,500
1916	681,470	416,808
1917	744,730	13,700
1918	808,600	271,170
1919	1,500,000	492,180

During the past five war years, production has undoubtedly suffered through lack of care and it is probable that planting in Nova Scotia in the last ten years has not been more than sufficient to take care of the average annual mortality. Some fairly large orchards, however, are only now coming into bearing, and it seems reasonable to expect an annual commercial crop in Nova Scotia for the next decade of about 1,000,000 barrels.

The leading commercial varieties of this district are the King, Gravenstein, Golden Russet, Roxbury Russet, Blenheim Orange, Ribston, Baldwin, Bishop Pippin (Bellflower), Stark and Ben Davis. The Nova Scotian Gravenstein, King, Blenheim and Russet are particularly well and favorably known on the English markets. The Gravenstein is undoubtedly the outstanding variety.

The climatic conditions are particularly favorable inasmuch as the apple area is practically an island, preventing extremes of temperature, and irrigation is, of course, unnecessary. Clean cultivation is the general rule, about

50 per cent of the orchards depending almost solely on commercial fertilizers.

For many years Nova Scotia has shipped her surplus crop to Great Britain, principally to London. Her shippers are particularly well situated to take advantage of this trade as they are all within a few hours of the ports of Halifax and St. John.

The chief disadvantage of the district is its comparative isolation from the large home markets. In order to compete with Ontario fruit on the large consuming markets of the northwestern provinces, Nova Scotian shippers start with a handicap of a rail haul of over twenty-four hours. With the European market open, this is not serious inasmuch as this market is capable of some extension.

Prince Edward Island and New Brunswick.

Prince Edward Island and New Brunswick do not grow enough apples for home consumption at the present time. Both these provinces, however, possess large areas with a soil and climate well adapted to the commercial production of the hardier varieties. Prince Edward Island has suffered in the past from the poor transportation between the island and the mainland but this has improved of late, and the apple industry should consequently be encouraged.

The St. John Valley of New Brunswick has excellent prospects as a commercial apple-growing district, and it is probable that the next ten years will show a very marked increase in the production in this province, which during the past decade ranged from 75,000 to 100,000 barrels. Fairly low temperatures are experienced in the winter, and the leading varieties are the Duchess, Fameuse, Alex-

Plate VI.— King apples growing in Annapolis Valley, Nova Scotia.

ander, McIntosh Red, Wolf River and Bethel. Most of the orchards are in sod. Transportation facilities are good from the St. John Valley, and its nearness to the seaboard would be a decided advantage when the production is sufficient to make an export trade desirable.

Quebec.

Apples have been grown in Quebec longer perhaps than in any other district in Canada, with the exception of Nova Scotia, records showing that they were produced in this province as early as 1663. The industry, however, has not developed to any great extent. The Fameuse is claimed to have originated in Quebec, and it and other varieties of the same type (Wealthy, McIntosh Red, St. Lawrence) reach a very high state of perfection. Pomme Grise, or French Russet, as it is sometimes called, has long been grown in Quebec. The commercial production is confined largely to the Island of Montreal, Como, LaTrappe, St. Joseph du Lac, Hemmingford and Covey Hill, Chateauguay, St. Hilaire, Rougemont and Abbotsford districts. The Census of 1911 gave the production of Quebec as over 400,000 barrels, but it is not probable that the average annual commercial production of the past two or three years has been more than 100,000 barrels. The orchards are principally in sod, many of them have not received proper attention and, in addition, it is estimated that fully 40 per cent of the trees were destroyed by the severe winter of 1917. There is evidence, however, of a revival in apple-growing, and some of the highest average returns for Canadian apples, in late years, have been made by Quebec orchardists.

Ontario.

Ontario still produces considerably over 50 per cent of the crop of apples in Canada, but only in limited areas is the industry specialized as it is in Nova Scotia and British Columbia. The exports in the past ten years have not been nearly so great as those of Nova Scotia, but this is due to the many large markets within the province, to the greater ease with which the Ontario shippers can reach the markets of the Northwest, which have been tremendously developed during the past decade, to the fact that the ports of export are not as convenient to Ontario shippers as to those of Nova Scotia and, particularly in the past four or five years, to the great risk and uncertainty attending ocean transportation. In the eastern part of the province, along the St. Lawrence and Ottawa rivers, are some very fine orchards of the Duchess, Wealthy, McIntosh Red and Fameuse type. The McIntosh Red, which for some years has been the highest priced apple on the Canadian markets, was originated at the town of Dundela in the County of Dundas in this district in 1830.

The largest orchards of Ontario are between Kingston and Toronto in what is commonly known as the Lake Ontario district. Prince Edward County, the southern part of Hastings, Northumberland, Durham and the southern part of the County of Ontario, grow all the standard varieties, and ship thousands of cars of apples annually to the large eastern markets and to the markets of Canadian Northwest. In addition, this section does a large export trade with Great Britain. The leading varieties for export are the Baldwin, Spy, King, Russet, Ontario, Pewaukee, Stark and Ben Davis, but large quantities of Duchess,

Wealthy, Fameuse, Wagener, Rhode Island Greening, Tolman, Canada Red, and Cranberry, are also produced. Many of the orchards in this district are more than a hundred years old, and the apple industry is perhaps more specialized and better organized than in any other part of Ontario. An outstanding feature of the apples grown here is their keeping quality. The climatic conditions are such that the trees do not start into growth as early as in southern Ontario and yet the season is sufficiently long for the best varieties to mature. Consequently the apples are just ready to pick at the approach of freezing weather and, when stored in ordinary warehouses, go into a natural cold storage where they retain their keeping qualities until the following spring. This saves the cost of cold storage, giving the shippers of this district a considerable advantage over more southern regions. Large storehouses have been erected along the railway lines at such points as Belleville, Trenton, Brighton, Colborne, Grafton, Port Hope, Newcastle, Bowmanville, Oshawa and Whitby. Colborne, for example, has over a dozen warehouses, with a capacity of more than 100,000 barrels.

In southwestern Ontario (including the Niagara Peninsula), while apples of high quality are produced in considerable quantities, the industry is not specialized, except in a few localities, such as Norfolk and Lambton counties. This district, however, has one great advantage as it is able to get its early apples on the market about two weeks earlier than any other part of eastern Canada.

Throughout western Ontario, particularly along the shores of Lake Huron and Georgian Bay, large quantities of apples of the standard varieties are grown. In the Georgian Bay district, the conditions are very similar to

those in the region north of Lake Ontario, and orcharding is carried on as a special industry, but in the greater part of western Ontario the apple orchard is usually a side line to general farming, and consequently the same attention is not given to the details of spraying, pruning, cultivating, packing and marketing as in the districts where apple-growing is the main industry. In the aggregate, however, the crop of western Ontario has a very marked influence on the commercial production of the province. The leading varieties are the Spy, Baldwin, King, Greening, Ben Davis and other standard sorts but as the distance from Lake Huron and Georgian Bay increases, the earlier and hardier varieties are more in evidence.

British Columbia.

The apple industry in this province is comparatively new, but has developed rapidly and along highly specialized lines, so that it is now a considerable factor in the marketable crop of Canada. The Dominion Census of 1901 credited British Columbia with 220,000 bearing and 170,960 non-bearing apple trees, while in 1911 the figures were 510,763 bearing and 1,465,622 non-bearing trees; and the increase in the last nine years has probably been fully 50 per cent. Following is a statement of the commercial production for the years 1911 to 1919 inclusive:

Table VI.— Production of Apples in British Columbia

Year.	Boxes.
1911	225,100
1912	386,640
1913	456,380
1914	615,600
1915	993,060
1916	1,376,310

Year.	Boxes.
1917	1,785,405
1918	1,378,005
1919	2,500,000

Many thousands of acres have just come into bearing within the past two or three years, while a considerable acreage is still not bearing commercial crops, and there will undoubtedly be a steadily increasing production for the next decade. To offset this, however, consideration should be given to the fact that there has been very little planting in the past five years and in addition the orchards of British Columbia have in some cases suffered through lack of care.

The most noted section is the Okanogan Valley, where the Coldstream Ranch, consisting of some 600 acres of orchard in various stages, is located; this was established about twenty years ago by Lord Aberdeen when Governor General of Canada, and is one of the oldest commercial orchards in the province. While the Okanogan is the largest section, in point of acreage devoted to apple-growing, thousands of acres of orchard have been planted during the past ten or twenty years in the Arrow Lakes, Kootenay and contiguous districts, along the Thompson and Fraser rivers to the Coast, and also on the Island of Vancouver.

The climatic conditions are very varied, both dry and wet growing seasons being found in the different fruit regions. In the Okanogan, a very extensive system of irrigation is in operation. The district being new, it has not yet suffered to any serious extent from the insect pests and diseases common to the more established fruit sections. In addition, a very rigid system of inspecting imported nursery stock has been in force for many years. The

apples are generally large in size, possibly owing to the fact that most of them are produced on young trees, are usually very highly colored and of high quality and, packed in boxes, reach the market in excellent condition.

Practically all the standard varieties of the East (Wealthy, Duchess, McIntosh Red, Spy, Wagener) are produced in large quantities in British Columbia, but in addition the Jonathan, Newtown, Rome Beauty, Winesap, Ontario, Grimes Golden, Winter Banana and Esopus (Spitzenburg) are grown to perfection. The crop is marketed principally within the province and throughout Alberta, Saskatchewan and Manitoba. When there are light crops in eastern Canada, comparatively large quantities of British Columbia apples have been shipped to Toronto, Montreal and Quebec and as far east as St. John, New Brunswick. Up to the present time, the largest export trade has been with Australia and New Zealand, the following table showing the exports to these countries during the years 1913 to 1917 inclusive:

TABLE VII.— EXPORTS TO AUSTRALIA AND NEW ZEALAND

Year.	Boxes.
1913	31,127
1914	40,816
1915	54,592
1916	70,000
1917	76,000

In 1918, owing to the Australian embargo on apples, there were no exports to that country, and only some 15,000 boxes to New Zealand.

British Columbia apples have also been exported to the markets of Great Britain, South America, the West Indies and South Africa, and an outlet is, therefore, being pre-

pared to take care profitably of the anticipated increase in production.

AUSTRALIA AND NEW ZEALAND

Australia, Tasmania and New Zealand have claimed attention in the commercial apple world only within recent years. Outside of North America, these countries are now the most important commercial apple regions in the world. The area in bearing apple trees is about 50,000 acres in Australia mainland, 25,000 acres in Tasmania and 15,000 acres in New Zealand and in all cases the acreage is increasing. The acreage of New Zealand is strictly commercial while some of that of Australia and Tasmania is not. The export to foreign markets amounts to several million boxes, and promises to increase. The commercial production of Australia, New Zealand and Tasmania is now about one-half that of Canada and one-tenth that of United States.

On the mainland of Australia, the orchard areas are principally along the coast, the larger portion being in the southern states and along the southwest coast of west Australia. In Tasmania the plantings are general and the only sections unsuitable for fruit-culture are the midlands along the west coast. In New Zealand the distribution is fairly general in both north and south islands except on the west coast. The main commercial plantings, however, are in the Nelson-Auckland districts.

The bulk of the crop in Australia, Tasmania and New Zealand is at the present time consumed locally, the annual foreign exports amounting to about one-fourth of the production. The principal outlet or foreign markets for these apples have been England and Germany, and the export trade prior to the war was increasing very rapidly.

From about 1910 to 1915, the plantings were very heavy but owing to war conditions and the consequent dislocation of markets, there has been very little increase in areas in trees since that date. However, with the return to normal conditions one may expect to see a decided spurt in planting. The tendency is to specialize in small holdings in order to overcome labor difficulties, and in some districts apple-growing is combined with general farming. The average orchard has from fifteen to twenty-five acres, so that most individual plantings are small. In this respect it is more like the northwestern orchards than the barreled apple sections of eastern United States.

The harvest season for Australian apples is a long one. Trees are picked over for the largest fruit about every two weeks from the middle of February to the middle of April, for export to England and foreign markets. The remainder of the crop and those varieties maturing too late for export are picked and stored either in packing-houses, in orchards, or in common storage and are then packed out at the owner's discretion. This means that fruit is being packed out nearly all the year. Picking and packing is nearly all by day labor. The fruit is wrapped and packed in a similar manner to the northwestern method. No standardization of grades has thus far been attempted, each individual grower making his own grades. The bulk of the Australian apples is harvested from February to May and reaches the foreign markets during April, May and June. They could be placed on American markets from March to August. In shipping the fruit, it is usually packed in bulk or boxes containing one imperial bushel or half bushel. Many canning factories buy fruit by weight. The general export varieties of Australia,

Tasmania and New Zealand are quite different from the sorts grown in the United States, although in many cases the more important Australian varieties are very important commercially in this country. The following gives the general export varieties somewhat in order of their importance:

Victoria	Tasmania	New Zealand
Jonathan	Sturmer	Dunn's
Ortley (Cleopatra)	Ortley	Coxe's Orange Pippin
Dunn's	Scarlet Nonpareil	Sturmer
Reinette	Jonathan	Jonathan
Coxe's Orange Pippin	Coxe's Orange Pippin	Yates
Sturmer	Ribston	
Emperor Alexander	Worcester	
London Pippin		

These varieties are among the more important, although others are constantly increasing. Jonathan is increasing everywhere on account of its good bearing qualities and relative freedom from diseases. Delicious is still in its infancy, but is taking well with both producer and consumer, and promises to increase rapidly. Esopus (Spitzenburg) is going out of favor as it is very subject to scab and is a biennial bearer. The Stayman is coming into favor in New Zealand.

In the care of the orchard, much the same method is followed as in the northwestern orchards, although very few sections are irrigated.

The trees are pruned on similar lines in Australia, Tasmania and New Zealand. They are usually cut back very severely for the first five years, and growers favor a strong frame-work of twelve to sixteen limbs, at as nearly equal distances from each other as possible; thereafter lighter pruning is practiced as trees come into bearing. The trees

are formed with an open center to admit light, thus encouraging fruiting, particularly in the lower part of the tree. Strong fruit-spurs on the main limbs are preferred, but laterals are used on some varieties, notably the Jonathan, in order to bring extra vigorous growers into earlier bearing. Most trees are planted from sixteen to twenty feet apart, and the orchards are kept more compact than in the Northwest. Australian growers claim that this gives greater efficiency in the orchard operations. The ladder is seldom needed for picking or pruning for the first ten years. The closer planting makes the yield to the acre equal to that of America. No doubt when these orchards obtain considerable age, the disadvantages of this closer planting system will be brought out.

The orchards are cultivated much the same as in America, and commercial fertilizers are used very extensively. It is also a common practice to sow cover-crops. Thinning the fruit is not a general practice and many growers try to combat over-cropping by systematic bud or spur thinning. Australian growers have not found that thinning has any marked effect in making annual bearers of those varieties given to biennial bearing.

Many of the same diseases and insects are prevalent as in America. The black-spot or scab is the worst disease with which the Australian growers have to contend. Woolly aphis (Australian blight) comes next, closely followed by the codlin-moth. In some of the more humid districts, mildew seriously affects many varieties. Bitter-pit has been especially bad on young trees. Fire-blight is not yet known.

Coöperative marketing is as yet little in evidence except in the direction and management of cold-storage

houses. Such propositions as these were formerly in the hands of the government, but under the coöperative management the charges have been reduced. Coöperation in this respect is increasing rapidly, especially in Victoria on the mainland. The Northwest in the United States is far ahead of Australia in coöperative methods of handling and distributing.

The Australians are agreed that they may learn much from America in the equipment of packing-houses, especially on labor-saving devices. Many Australians are particularly proud of their pruning methods and in this respect they are convinced that the American orchardist might learn something from them.

CHAPTER IV

LOCALITY AND SITE FOR THE COMMERCIAL ORCHARD

BEFORE investing in an apple orchard, both the locality and specific site should be carefully considered. Circumstances may often prevent the free choice of a locality, but the site of the orchard is usually within the direct control of the grower, and may determine largely the success of the enterprise.

CHOOSING THE LOCALITY

The fruit-grower should know the advantages and disadvantages of the different apple-producing regions; therefore, each important apple region will be discussed briefly and some of the factors of interest in this connection set down. In Chapter V will be discussed the factors which govern the proper selection of the site for an orchard within a given region.

WESTERN NEW YORK

Advantages.

1. Western New York is an established, well developed and productive apple region, prominent in the apple industry for over a century.
2. Land values have been reasonable in comparison with those in other apple regions.
3. The bulk of the production is of standard commercial varieties well adapted to the section.

4. Western New York is a stable progressive region, where land booms do not flourish and where there is not over-specialization of any particular crop.

5. It enjoys proximity to market and has excellent facilities for storing and handling fruit.

6. The land is easily worked and the maintenance cost is not excessive.

7. This region is rather densely populated and sufficient labor is usually available from the nearby towns and cities during harvest time.

8. Good yields.

Disadvantages.

1. The varieties, Baldwin and Greening, for which this section is best known, are not of the highest quality and as a rule under-sell such varieties as Winesap, Jonathan and Grimes.

2. Orchards are susceptible to scab and in many cases the crop has been practically ruined and the percentage of high-grade fruit cut to a minimum on account of this disease.

3. The average orchard in western New York does not receive the highly intensive care which characterizes some other regions. This disadvantage can be remedied by the individual owner, however, and is not inherent to the region.

4. Bearing orchards are well advanced in years and do not as a rule bear the high percentage of fancy fruit which may be expected from young trees.

5. Trees are slow coming into bearing.

6. Rigorous winters are common.

HUDSON VALLEY

Advantages.

1. The Hudson Valley enjoys the distinct advantage of close proximity to market. The growers in this region are enabled to keep in intimate touch with trade conditions in New York City and are able to place their fruit on the market within a few hours from the time it is shipped.

2. Fancy trade varieties of apples can be grown profitably and

marketed successfully by catering to specialized trade. Such varieties as McIntosh, Northern Spy, Oldenburg (Duchess), Gravenstein, Wealthy and Fall Pippin, which are adapted to this region, lend themselves well to the development of such trade.

3. Land values have been very reasonable in the Hudson Valley.

Disadvantages.

1. The annual yields of the Hudson Valley are smaller than those of western New York; also smaller than the Shenandoah-Cumberland region.

2. On the whole the soil is not as rich as in western New York and, although adapted to many varieties, requires considerable fertilization in some instances to secure good annual crops.

3. Orchards are not entirely free from occasional severe winter injury.

4. Land does not lend itself so well to general farming and is in places quite rolling.

5. Rigorous winters are common.

CHAMPLAIN DISTRICT

Advantages.

1. The Champlain district, bordering Lake Champlain and Lake George in New York and Vermont, is especially adapted to such high quality varieties as Northern Spy and McIntosh.

2. The high prices for its fruit, fair yields and reasonable proximity to important markets argue in favor of this region.

Disadvantages.

1. Trees in this region are rather slow growing, seldom attain the size, and do not as a rule produce the high annual crops common to western New York.

2. Although McIntosh seems to be reasonably safe from winter-injury, other varieties occasionally suffer severely from winter-killing.

3. This locality is not of sufficient size to warrant the competition among the buyers which is generally found in the larger districts.
4. The region is less accessible than such districts as the Hudson Valley.
5. Rigorous winters are common.

NEW ENGLAND

Advantages.

1. The outstanding advantage of New England orchards is their proximity to centers of consumption such as Boston and other large cities.
2. Foreign export trade draws rather heavily on New England production, particularly has it been partial to Maine Baldwins.
3. Land values are reasonable.
4. The revived interest in apple-growing is serving to bring to prominence a number of specialized districts which are capable of producing exceptionally fine fruit. An instance is the Wilton district in southern New Hampshire.
5. Particular localities in New England are suited for growers who desire to specialize on such fancy varieties as McIntosh and Wealthy for which a special trade can be built up.

Disadvantages.

1. In general, New England orchards are small, rather scraggy, and include relatively few highly commercial and intensive plantings such as are found in western New York and the Shenandoah-Cumberland region.
2. Scattered plantings and limited production from any particular region naturally limit the possibility of coöperative effort among growers in marketing their fruit at the highest prices.
3. The industry and production of New England as a whole has declined very materially in the ten years prior to 1919. The future of apple-growing in this region probably depends on the development of small specialized projects rather than on large or general commercial planting.
4. Rigorous winters are common.

NEW JERSEY-DELAWARE PENINSULA

Advantages.

1. This region enjoys an almost unequaled advantage of close proximity to New York and Philadelphia markets.

2. It is adapted to the production of varieties such as Yellow Transparent, Wealthy, Williams, Early Ripe and Starr. Southern New Jersey is particularly suited to the production of Yellow Transparent, Williams, Early Ripe and Starr, while English Codling, Gravenstein, Duchess, Twenty Ounce and Wealthy are well suited to Monmouth County.

3. Orchards in this region respond to good care, and, although fertilization is sometimes necessary, are generally productive.

4. Cost of production in this section has not been excessively high and good prices have made the orchards profitable as a rule.

Disadvantages.

1. Orchard diseases and pests present a somewhat difficult problem for the commercial grower. Late attacks of codling-moth are occasionally very destructive.

2. This region is not as well adapted to the growing of winter varieties as some of the other eastern districts.

SHENANDOAH-CUMBERLAND REGION

Included in this region are the following important apple counties of southern Pennsylvania: Adams, Franklin and York; also Washington County, Maryland; Berkeley and adjoining Panhandle counties of West Virginia, and the Shenandoah Valley of Virginia.

Advantages.

1. A large part of the apple acreage of this region is just coming into bearing and an increased production of high-grade fruit may be expected from this young and well-cared-for acreage.

2. The leading varieties, York Imperial, Ben Davis, Stay-

man and Grimes, comprise the bulk of the production and are well known as profitable varieties.

3. Yields average with those of the best eastern orchards.
4. The region enjoys reasonable proximity to markets.
5. Centralization and intensity of plantings offer excellent opportunity for coöperation and regional development.
6. Fairly cheap labor is ordinarily available.

Disadvantages.

1. Although one of the most promising eastern apple regions, the Shenandoah-Cumberland is not entirely free from certain disadvantages. Cedar rust is severe in some parts of this region on York Imperial and Ben Davis trees; pine and meadow mice have been doing considerable damage to many of the trees and root-rot occurs in some localities.
2. Land values at this time are relatively high, and for that reason the prospective investor would need considerable capital to get started.
3. Hail injury is not uncommon.

PIEDMONT REGION OF VIRGINIA

Advantages.

1. For scenic beauty this region is unexcelled.
2. Land is cheap and plentiful. Orchard values have been fairly reasonable.
3. Good transportation facilities.
4. Labor conditions are generally satisfactory throughout the region.
5. High-grade varieties such as Winesap and Yellow Newtown (Albemarle Pippin) predominate and sell for high prices.

Disadvantages.

1. Bitter-rot is particularly injurious in certain seasons.
2. Yields are lighter than in the Shenandoah-Cumberland or western New York regions.
3. The orchard land is generally mountainous and somewhat hard to work.

4. Very poor roads occur in some localities and some of the best apple land is relatively inaccessible.

5. Hail damage is very common, particularly on higher elevations, and unfavorable conditions are often present at blooming time, rendering the crop uncertain.

SOUTHERN OHIO ROME BEAUTY SECTION

Advantages.

1. Land values have been relatively reasonable in price.
2. The region is fairly close to important markets.
3. Quality of fruit, particularly that of the Rome Beauty, is good.

Disadvantages.

1. Yields are generally lower than in western New York or most other eastern districts.
2. The land is rough and mountainous and the orchard plantings are somewhat isolated.
3. Much of the fruit has to be ferried across the Ohio River.
4. Frost-injury does occasional damage in the spring.
5. The soil is naturally poor and requires considerable fertilization, particularly in the form of nitrates.

WESTERN MICHIGAN

Advantages.

1. Western Michigan is an established, well developed and productive apple region, prominent in the apple industry for many years.
2. Land values have been reasonable.
3. It enjoys proximity to important markets in large central west cities.
4. Yields are good.
5. Higher quality varieties are grown in Michigan than in most other middle western states.

Disadvantages.

1. Frost-injury is not uncommon.

2. There are many old and rather neglected orchards, particularly in the south and southeastern part of the state which lower the quality of the general output from the state.

3. Michigan orchards are susceptible to apple-scab and in some cases the crop has been severely injured on account of prevalence of this disease.

4. Winter-injury to trees is not uncommon.

ILLINOIS

Advantages.

1. Proximity to markets.

2. Relatively good yields in western Illinois, but rather light yields in southern part of the state.

3. Orchard values have been relatively low in comparison with land values.

4. Early apple section in extreme southern Illinois is particularly adapted to the production of early varieties.

Disadvantages.

1. Fungous diseases are more or less prevalent and blister-canker has caused considerable loss among Ben Davis and Gano plantings.

2. Apple plantings are less centralized than in most commercial districts and community interest is lacking in some instances.

3. Quality of fruit is variable. Such low-grade varieties as Ben Davis and Willow Twig predominate in many regions.

4. Unfavorable climatic conditions at blooming time are not uncommon.

OZARK REGION

This region includes intensive apple plantings in northwest Arkansas and southwest Missouri.

Advantages.

1. Labor conditions usually favorable.

2. Possibility for the renovation of old orchards.

3. Yield and quality in well-cared-for orchards good in certain years.

4. Land values reasonable.

Disadvantages.

1. The region has many old and neglected orchards which decidedly detract from community spirit and progressiveness and lower the quality of the output from the region as a whole.

2. Ben Davis and Gano plantings which predominate are particularly susceptible to very serious attacks of blister-canker.

3. Unfavorable weather at blooming time often prevails and crop failures are not uncommon.

4. Average yields low.

5. System of bulk handling of a large part of the crop is not conducive to close grading and the maintenance of high commercial standards.

MISSOURI RIVER REGION

In this region are included the intensive commercial apple districts of northwestern Missouri, northeastern Kansas, southeastern Nebraska, and southwestern Iowa, in what is sometimes called the loėss soil apple region.

Advantages.

1. A progressive spirit prevails to a greater extent than among most other middle western regions.

2. The loess soil of this region is exceptionally fertile and exceptionally productive.

3. Yields are good on the well-cared-for orchards.

4. Although Ben Davis and Gano predominate, considerable importance is being given to Jonathan and Winesap plantings which do very well in this region.

Disadvantages.

1. Fungous diseases are more or less prevalent.

2. Unfavorable weather conditions at blooming time are not uncommon.

PLATE VII.— A young irrigated orchard in the Bitter Root Valley of Montana, showing the clean cultivation formerly practiced in the Northwest.

3. The region is not entirely free from many old and neglected orchards, particularly throughout northwestern Missouri.

4. The bulk handling of a large part of the crop does not encourage high uniform grades.

WESTERN SLOPE OF COLORADO

In this region are included Mesa, Montrose and Delta counties.

Advantages.

1. This enjoys the advantage of being closer to eastern markets than the other boxed apple regions.
2. Although the orchard land is somewhat spotted, high quality fruit and good yields are possible in favorable seasons.
3. Facilities for handling and marketing the crop are fairly well developed.

Disadvantages.

1. Much unsuitable land has been planted and exploited to the disadvantage of the incautious investor.
2. This region includes some very fine orchards and at the same time some very poor ones, making generalities very difficult.
3. The average yields are not as high as in the Northwest.
4. Frost-injury in the spring occasionally causes heavy loss, particularly in the Grand Valley. The menace of the codlinmoth is another factor which should be considered by the prospective investor.
5. Alkali seep has destroyed entire areas of orchard lands in certain localities, particularly in parts of the Grand Valley.
6. Distance from market.

UTAH

Commercial apples in Utah are produced almost entirely in the irrigated valleys along the western slope of the Wasatch Mountains. Important counties are Boxelder, Weber, Davis and Utah, which include many commercial apple plantings. Conditions are somewhat variable, but in the main the advantages are:

1. A somewhat greater local demand for apples than occurs in the Northwest.
2. Lower orchard values.
3. Good quality fruit and considerable young acreage.

Disadvantages.

1. In some instances unsuited land has been set to apple trees and conditions are variable.
2. Annual yields, although very good, are somewhat less than in the Yakima and Wenatchee valleys.
3. The limited size of the industry does not permit of the development of marketing facilities such as may prevail in heavier producing regions.
4. Frost damage is occasionally severe.

IDAHO

Heaviest commercial apple plantings in Idaho are in the Payette and Boise valleys, tributary to such towns as Payette, Fruitland, Caldwell and Boise. The advantages of this region are:

1. Young acreage, very little of which has attained full bearing and most of which is relatively free from insects and diseases.
2. Quality of the fruit is excellent, particularly Jonathan, which is the leading variety.
3. Yields are good, but somewhat lower than in the Yakima and Wenatchee regions.
4. Orchard values are somewhat lower than in some of the other northwestern orchard sections. The region described is a very good general farming section, having a rich soil which responds well to irrigation, a universal practice.

Disadvantages.

1. Some unsuited land was developed and exploited with apple plantings.
2. Frost damage has almost entirely destroyed the crop of this region in certain years.

3. Distance from market is a severe handicap.
4. Some alkali trouble in the lower lands.

The Twin Falls irrigated region in the extreme southern part of the state is a very fertile general farming country, with considerable apple plantings, some of which have been pulled out in recent years. Apple-growing as a specialized industry is being supplanted by greater diversification.

WASHINGTON

Yakima Valley

Advantages.

1. Exceptionally high annual yields of fine marketable fruit.
2. The prevalence of good commercial and heavy bearing varieties.
3. Ideal climatic conditions.
4. Highly centralized plantings, with exceptional facilities for handling and storing fruit.
5. Greater possibilities for diversification than in the Wenatchee Valley.
6. Good roads.
7. Freedom from fungous diseases.
8. Exceptionally high class of people engaged in the fruit industry, with exceptionally good social conditions.

Disadvantages.

1. Land values very high.
2. Irrigation necessary.
3. Excessive distance to market.
4. Heavy infestation of codlin-moth.
5. Fire-blight prevalent, particularly among Esopus (Spitzenburg) trees.
6. Many farms do not permit of any diversification.

Wenatchee

Advantages and disadvantages in the Wenatchee Valley are in the main identical with those in the Yakima Valley. Yields in Wenatchee are somewhat higher and the percentage of extra

fancy and fancy fruit will run somewhat higher. On the other hand, the limited area in the Wenatchee district will not permit of the diversification possible in the Yakima Valley. Fire-blight has not caused serious loss to the Wenatchee growers. In general, land values for the Wenatchee Valley are somewhat higher than in Yakima. Frost damage at blooming time in the Wenatchee Valley is almost unknown and heavy annual crops are fairly certain. Considerable difficulty is often experienced in getting the fruit to market in the fall.

Spokane district

Many of the same advantages and disadvantages prevail in the Spokane district as in the Yakima and Wenatchee. However, a greater proportion of unsuited land is planted to trees in Spokane County than in either the Yakima or the Wenatchee district; the yields are generally lower and more uncertain; frost-injury is more frequent; and fungous diseases are more prevalent. While nearly as many acres have been set in Spokane County as in Yakima County, a considerable percentage of this acreage was planted on non-irrigated and less productive soil than is in the Yakima and Wenatchee Valleys.

MONTANA

Commercial plantings in Montana were largely centralized in the Bitter Root Valley which suffered considerable over-development. Many boom projects were planted which never attained commercial bearing. The region is adapted to growing of McIntosh apples; the elevation is high; frosts are not uncommon and the trees do not attain the size, nor do they produce the high annual crops that are common in many of the other northwest irrigated regions.

OREGON

Hood River

Advantages.

1. High-grade varieties such as Yellow Newtown and Esopus (Spitzenburg) predominate.

2. A high class of persons is engaged in fruit-growing; climate is delightful; scenery beautiful and social conditions good.
3. Centralized planting.
4. Good storage and shipping facilities.
5. Fruit very well known and widely advertised.
6. Prices received for output relatively high.

Disadvantages.

1. High land values.
2. Little opportunity for diversification.
3. Yields much lower than the average for the Wenatchee and Yakima valleys.
4. Apple-scab bad in certain years.
5. Distance from market.

Rogue River Valley

Advantages.

1. Climatic and social conditions ideal; beautiful scenery.
2. Good roads and centralized planting.

Disadvantages.

1. Drought has greatly reduced the crop in certain years, although irrigation is being adopted in some sections.
2. Land values relatively high.
3. Adapted to pear- rather than apple-growing.
4. Frost-injury occasional.
5. Yields low.
6. Distance from market.

CALIFORNIA

Watsonville district (Santa Cruz and Monterey counties).

Advantages.

1. Heavy annual yields, particularly where orchards have been grown in the heavy "redwood" soils.

2. Marketable quality of fruit good, but lower than in the Northwest.
3. Good shipping and storing facilities, also good roads.
4. Very centralized planting, practically all within ten miles of Watsonville.
5. Cost production of apples relatively low.
6. Good varieties grown, consisting almost exclusively of Yellow Newtown and Yellow Bellflower.
7. No irrigation required.
8. Highly developed dried apple industry.

Disadvantages.

1. Internal browning, a physiological disease, prevalent in Yellow Newtown apples in certain years, detracts from storing qualities of this leading variety.
2. Coöperative movement among growers working for high grades and better marketing facilities has not been as great as in many of the northwest apple-growing regions.
3. Lack of effort towards establishment of high grades has resulted in a lower price received for the fruit than for the same variety grown in such regions as the Hood River Valley.
4. Rural social conditions are inferior to those found in the newer regions of the Northwest.
5. Distance from eastern markets.

Sebastopol section (Sonoma County)

Advantages.

1. Particularly adapted to the production of Gravenstein, a profitable variety.
2. Relatively free from serious insect and disease injury.
3. Local demand for output tends to offset the great distance from eastern markets.
4. Highly developed dried apple industry
5. Coöperative and community spirit apparent in most of the apple-growers.

Disadvantages.

1. Yields more uncertain and somewhat lighter than in the Watsonville section.
2. Distance from eastern markets.

NEW MEXICO

Although some commercial apple plantings are found in the Rio Grande Valley and in the Farmington district in San Juan County in the extreme northwestern part of the state, interest in New Mexico centers chiefly in the Pecos Valley where the heaviest apple plantings are in Chaves County in the vicinity of Roswell. The advantages of this county are:

1. Acreage is young, in many cases well cared for and capable of producing high quality fruit in favorable seasons.
2. Proximity to Texas markets, particularly advantageous for the Jonathan crop which matures earlier than in the Northwest.

Disadvantages.

1. Occasional frost-injury which destroys large portions of the crop.
2. Lighter yields than in many of the northwest irrigated sections.
3. Region difficult of access.

The above discussion of some of the advantages and disadvantages common to the more important apple regions will serve in a general way to outline briefly the conditions to be expected in different parts of the United States. It is not to be considered complete and is undoubtedly inapplicable to many individual cases.

The purchase of a farm is one which requires more intensive study and consideration than such generalizations as have been given. The long period of years required to bring an orchard to full bearing signifies a long term of ownership. Fruit-growing is not entirely comparable with

general farming and as is the case with all specialized industries the inexperienced individual is at somewhat of a disadvantage in passing on the relative merits of different investments.

CHOOSING THE SITE FOR A FRUIT-FARM

In the purchase of a fruit-farm, the prospective investor should keep many points in mind. In the following discussion, the more important points will be considered in the purchase or selection of a site for an apple orchard.

Raw versus planted land.

The first problem is whether to purchase a bearing orchard or to buy raw land and set trees. The relative cheapness of undeveloped land is usually a most attractive feature and the investor very often overlooks the fact that it requires from eight to ten years in irrigated sections and from twelve to fifteen years in non-irrigated districts for an apple orchard to attain real commercial bearing. If the investor has other income or can afford to wait for returns, the planting of an orchard in a favorable locality will usually prove profitable.

Buying raw land in the hope of paying for its development and of making a living at the same time by farming between the rows is seldom feasible. No definite recommendations can be made to fit all cases, but as a rule the more profitable ventures result from the investment of at least a part of the available capital in bearing orchard. Very often adjoining raw land may be purchased which can be set to trees if the owner desires to extend his plantings.

Time to buy.

The time to buy is usually when every one wants to sell, although this does not determine the relative merits of the different purchases. The place to buy is in a recognized fruit region. Apple-growing is an established industry and one which will prove profitable over a long period of years, but which may not pay for a short period. No farming enterprise has experienced the ups and downs of fruit-growing. The men who made money were those who, through far-sightedness or good fortune, invested when the tide was low and who remained in the business. A period of good years will always follow one of poor years, and the fact that apple production is not highly sensitive to demand protects the man who invests at the proper time. For example, the total acreage set to apple trees in the decade 1910 to 1920 has been small considering the United States as a whole. It would appear from this that the present apple-growers are approaching a period of prosperity. The cyclic tendencies of apple-growing are exceedingly important from the investor's standpoint, and much depends on the particular time that an investment is made.

Syndicate projects.

Investment in syndicate farms or large orchard projects has been discussed elsewhere. It has been the observation of the writers that syndicate farming of any kind, on any type of soil where the owner does not directly oversee the operations, is seldom successful. The same is true to a great extent for large orchard projects. Prospective investors would do well to avoid strictly all so-

called orchard projects, particularly those in which the tracts are to be managed by promoters and turned over to the purchaser after a period of years. The purchase of slightly run-down orchards at reasonable prices has often resulted in good returns, particularly when the trees are of good varieties. The question of renovation will receive separate treatment.

Yields and varieties.

Separate chapters are devoted to the discussion of yields and to the selection of varieties. Before choosing a farm, both of these points should be carefully considered. Reliable performance records over a period of five years will indicate the relative productivity of different varieties on typical orchards of any given region. This is a far more reliable guide than to judge productivity by the apparent size and vigor of the trees. A few well-known commercial varieties adapted to the district are always to be desired. Phenomenal yields occur at times in nearly every region, therefore the average rather than the maximum should be sought as a basis for calculation. The biennial bearing is fairly well pronounced in most regions and the lean years must always be considered.

Proximity to market.

In years of low prices the marginal regions or those remote from market suffer most keenly, since freight rates consume an inordinate proportion of the returns. This should not be overlooked when one contemplates buying an orchard at a great distance from market. Exceptionally high yields and excellent quality of the fruit may

overcome in a measure the burden of heavy freight charges. Thus two of the most extensive apple-growing regions in the United States have developed in Washington, many hundreds of miles from the primary apple markets. The freight on apples from the Yakima and Wenatchee valleys represents a very considerable item. Granting such notable exceptions, great distance from market must always be viewed as a decided handicap. Losses incident to car shortage, damage in shipment and difficulties due to long range business transactions are always emphasized under such conditions. Railroad facilities, advantages of competitive systems, and the possibility of boat shipping are worthy of careful consideration.

Distance from shipping station.

Improved roads and automobile trucks are making long hauls more economical and yet the distance from the orchard to the shipping station is a most important factor in determining the price of land. The investor can afford to pay considerably more for orchard land near a shipping station. Investigations in 1914 on 179 farms in the Hood River Valley and in western Colorado indicate that the average cost of hauling the shooks to the farm and the packed fruit to the station represents approximately one cent a bushel for each mile. The cost to-day, however, is about two cents.

Taking this present figure in considering an orchard yielding 225 bushels or 75 barrels to the acre, each additional mile in the distance from the shipping station would represent in these two items alone an annual cost of $4.50 an acre, or $45 an acre where the distance was ten miles. The cost of hauling other supplies has not been

considered, nor the social proximity to towns and cities. Furthermore, possible injury to fruit subjected to excessively long hauls over rough roads is not an unimportant feature.

In considering long hauls to shipping stations, it is interesting to note that in the Piedmont section of Virginia not infrequently a load of Albemarle Pippins may be hauled thirty miles over rough mountain roads. In the mountains of North Carolina and Georgia one may see a mountain schooner laden with apples en route to a town some seventy-five miles distant. The latter somewhat commonplace occurrence is usually in complete disregard of any existing railroad facilities. In many of these more remote regions oxen furnish the motive power. In such regions a three- or four-day trip to town with a load of apples takes more the form of an outing and cost production is irrelevant.

Unfortunately, long hauls and poor roads commonly go together. As roads improve and automobile trucks come into more common use, distances to stations will assume less importance. At present the prospective investor should consider it highly desirable to have less than a six-mile haul.

Bearing age of trees.

In considering the purchase of a very young orchard, one should not be misled by exaggerated accounts of early bearing. The age at which trees come into full bearing is somewhat variable, depending on the variety and the region. Statements regarding the large annual yields which may be expected from five- and six-year-old trees are largely untrue. Occasionally trees of this age bear

considerable fruit, but in buying young acreage one should seldom figure that an orchard will attain even fair commercial bearing before eight years for irrigated sections or ten to twelve years for non-irrigated districts. The age at which trees cease to be profitable depends somewhat on the region, but more on the care and variety. Most of the bearing orchards in western New York are forty or more years old and some remain profitable at fifty and even sixty years. These trees have received moderately good care. Those which have been allowed to break down, to become infected with disease and insect pests, and which have not received proper cultural treatment have long since passed out of profitable bearing.

The matter of longevity is often brought up in connection with investment in irrigated orchards. The question is asked whether irrigated trees forced into early bearing will be profitable at the end of fifty years as is the case with some New York orchards. Early maturity usually indicates shorter life. If the western growers would maintain fertility by cover-crops and by the application of fertilizer in quantities commensurate with crop production, the drain on soil fertility would be largely offset. Greater care and protection given the trees against insects and diseases will also have an important influence on the life of the trees in these intensive regions. Since practically all the commercial orchards on irrigated land have been set out in the past twenty-five years, there are no concrete examples as a basis for comparison.

In speculating on the longevity of the irrigated orchards, it is safe to say that the present plan of close planting must be greatly modified to meet the increased size of the trees. At present the average planting distance is

under thirty feet. An ultimate removal of one-third to one-half of the trees seems almost unavoidable. Even under such circumstances it hardly seems probable that the western irrigated orchards will remain in profitable bearing as long, for example, as the western New York orchards, the reason being not the longevity of the trees so much as the necessity for producing the highest grade fruit. The success of western irrigated orchards has been in the marketable superiority of its fruit. High quality fruit is more easily produced on young trees and it seems probable that the western grower will be inclined to abandon older orchards and set new trees which quickly come into bearing under his system of orchard management.

Diseases and insect pests.

Several commercial apple regions have entirely passed out of existence on account of the prevalence of certain insects and diseases. A bewildering list of insects and diseases might be suggested to the prospective investor since each locality has a special number of pests which are more or less serious. This subject is treated more fully in Chapter X.

In most regions spraying enters very materially into the cost of production, representing in some cases over 12 per cent of all costs. This figure, however, is only an item of expense. It in no way indicates the loss in fruit or injury to trees which may result from the depredation of prevalent orchard pests.

The prospective investor would do well to study the spraying program of the locality which he is considering and inform himself as to the number and character of the applications necessary to the production of high marketable

quality fruit. There may be a great variation even among orchards in the same locality. Once pests have gained a foothold in an orchard, their eradication may be an expensive process. Newly developed regions with young trees are as a rule singularly free from insects and disease. They are not guaranteed immune, however, for sooner or later the pests which might be expected to thrive under such conditions usually appear. Vigilance in controlling early infection will very materially reduce later loss.

Some pests are very much more expensive to control than others. Apple-scab, apple-blotch, and bitter-rot are serious fungous diseases which the prospective purchaser should keep in mind, not that they should be absolutely avoided, for one or more appears in many very important regions, but that their degree of prevalence should be considered. It makes a difference whether one or two fungicide applications will suffice for their control or whether five or six may be necessary. In some regions one spray controls codlin-moth, in others six to seven applications may be required.

A careful inspection of an orchard at harvest time will usually reveal the loss in fruit which may be expected from insects and diseases, although in some instances and particularly with fungous diseases, the extent of the injury varies widely in different seasons.

Climatic influences.

Climatic influences should be carefully considered in relation to the purchase of a fruit-farm. The critical period for the apple crop is at the time the trees are in bloom. Frost-injury to the blossoms or damp rainy weather to prevent pollination are the most frequent

causes of crop failures. Official weather reports will assist the investor in determining whether damp rainy weather and days of low temperature are common during the blooming period. A commercial project embracing several thousand acres of orchard land has developed in a region where frost occurs in practically every month of the year and where the minimum temperature during the blossoming time clearly indicates that frost-injury is unavoidable. An occasional dip in temperature to a point slightly below freezing does not necessarily signify excessive frost-injury, but recurring temperature at this critical period of 27° F. or lower is significant of probable injury.

The question of a particular site within a given region very often has an important bearing on susceptibility to frost-injury. A north or northeastern slope is usually preferred on account of its tendency to retard growth in the spring until danger has passed. Frost-injury is extremely erratic at times, striking here and there in an almost inexplicable manner. A fatal temperature on one occasion may result in very slight damage at other times. Other things being equal, higher elevation is preferable on account of better air drainage, and also soil drainage. The tendency of cold air to settle from high to lower land makes pockets and valleys without broad outlets comparatively dangerous. An example is afforded in the Rogue River Valley near Medford, Oregon. The orchards on the higher land, known as the foothill orchards, are much less susceptible to frost-injury than those on the floor of the valley; sufficiently so that the practice of smudging, still common in the latter orchards, has been largely discontinued on the foothills.

Damp rainy weather at blossoming time may be even a more serious factor than frost, since it prevents insect activity in pollination; furthermore, it interferes greatly with necessary spraying operations. Such unfavorable weather conditions often exist throughout the Middle West at blooming time. Hail injury and loss by heavy windstorms are much more prevalent in certain regions than in others. While personal investigation of the important points is necessary, reference to official weather records will prove an invaluable guide. Meteorologists agree that climate does not change, but state that it may run in cycles. A study of a several year period is, therefore, advisable.

Size of farm.

The size of farm to buy depends on whether apple-growing is to be the sole or only one of several important enterprises. A discussion of farm organizations has been given elsewhere. An orchard of less than fifteen acres even in the most intensive regions seems hardly advisable, since the overhead for equipment and general supervision would scarcely permit economical management of a smaller acreage; furthermore, the gross income would necessarily limit very large returns. The average farm in the intensive irrigated sections is scarcely over ten acres and twenty acres is often considered more than one man can handle. There is a surprising relation between the maximum yields and limited acreage, particularly for the farmer who diversifies. In other words, a small acreage well cared for very often gives a greater total production than a much larger acreage. For the intensive apple-grower, an annual production of at least 5,000 bushels is necessary to insure

a fair labor income. The acreage will of course vary with the regions. For the more general farmer, the size of the orchard should be governed by the acreage to which careful attention can be given. Ten acres or even less may be advisable since an orchard very often suffers from a pressure of other farm work. The day of poorly cared for commercial orchards has passed.

Necessary capital.

All available capital should not be invested in raw land for planting or in non-bearing orchards. The more or less hazardous nature of specialized farming emphasizes the need for sufficient capital to tide the farmer over the poor years. The fruit-grower must follow a far-sighted policy if he is to maintain his orchard in a high state of productivity. Such a policy requires considerable expenditure at times when there may be no returns. If the trees are allowed to suffer one year, the effect may be noticeable for many years to come. Neglected orchards are explained in many instances by the owners not actually having available capital to meet necessary expenses. It is not because they fail to recognize the wisdom and importance of careful spraying, pruning and the like, but rather because immediate needs for living expenses must receive first consideration.

Specialized apple-growing can not be undertaken successfully on the small margin which suffices for general farming. In other words, the investor who expects to devote himself exclusively to apple-growing should have several thousand dollars or outside income in order that he may safely buy and operate a farm sufficiently large to yield a good labor income. Nothing less than a 50 per

cent payment should be considered as a safe margin in buying a full bearing orchard. For a non-bearing orchard, the buyer must carefully figure the outlay required to bring the trees to full bearing and also his living expenses for the meantime. Inter-crops may help to defray some of the running expenses, although there is a tendency to over-estimate income from this source.

This leads to a discussion of the amount of money which the investor may expect to borrow when apple land is given for security. Attractive terms often may be secured at the time of purchase, particularly when the owner is anxious to sell or is getting a good price for his land. In such cases the purchaser may not require additional capital beyond his first payment. However, if he is obliged to seek credit from a banker, he may be surprised to learn that apple trees are not always considered a permanent improvement and in such cases appraisals for loans are based on the value of the land for general crops. Such has been the decision rendered by the Federal Loan Board in establishing a basis for loans on fruit lands throughout the country. Individuals may of course show a different attitude, considering that although the fruit-trees may not be considered permanent improvement, the land may have a greater value on account of its ability to produce exceptionally fine fruit. Credit will always retain much of the personal element and will vary with the prosperity of the apple industry. Furthermore, coöperation among growers and the influences tending to stabilize the industry may be expected to reflect materially on credit and current interest rates.

For the farmer with less than several thousand dollars' capital or who does not wish to devote himself ex-

clusively to apple-growing, the selection of a more general farm in a recognized apple section where land values are not too high, will afford an opportunity of gradually working into the apple industry. A small bearing orchard would serve as a nucleus and the returns from it could be used in developing additional plantings. Furthermore, the experience gained from caring for the older orchard would be profitable as a guide for the development of more acreage. A 100- to 200-acre farm with five to twenty acres of well-cared-for apple trees is a good arrangement and one which would have the advantage of safety, better credit and lower interest rates. The farmer's living expenses could be secured from the general farm land, leaving him independent of his apple crop in years of failure.

Labor conditions.

Labor conditions may affect greatly the advisability of choosing a fruit-farm in certain localities. Labor costs in some instances exceed 50 per cent of the total cost of producing apples, exclusive of interest on investments. Much of this labor is performed by the grower himself, although at harvest time and with such intensive operations as spraying and thinning, the character and price of available labor is very important. A study of the scale of wages for orchard labor reveals a disparagement of 50 per cent between different regions. Beginning with the low wage scale in southern states, labor rates increase and are at their highest in the Northwest.

The amount of work done in a day enters into all calculations and cheap labor may be the most expensive in the end. For example, the average picker in the Northwest picks about twice as many apples as the average

southern laborer. The losses incident to a scarcity of labor at harvest time, when all the fruit may be lost if not picked and disposed of within proper season, need not be emphasized. The subject of available local labor supply should receive careful attention by the investor.

Social conditions.

A factor which has entered very materially into the development of most commercial apple regions is the question of social advantages. One should carefully consider social conditions before investing in fruit land. Fruit-growing is usually looked on as a pleasurable and interesting pursuit. Furthermore, intensive fruit regions are necessarily thickly settled and provide social advantages superior to those in the average rural communities. The desire to live among educated persons and to have the advantages of excellent schools and churches and means of social recreation is strong. A farm in a community where such conditions prevail unquestionably has an added commercial value.

Fruit-growing has always attracted city people, and in specialized fruit regions to-day are many who, after retirement from business, sought fruit-growing as a healthful vocation and yet one which might be expected to offer fair returns on investment. If one seeks an isolated location for a fruit-farm, opportunities for converting the property into cash in case it is desirable to sell will be few, since the class of persons attracted to fruit-growing will look particularly for favorable social conditions. Social advantages should not completely sway one's business judgment, however, and should enter into consideration as only one of a number of important factors.

Regional developments.

Closely allied with social conditions as a factor in influencing choice of a farm is the question of regional development. The advantages of a centralized industry where all are interested in a common end need scarcely be enumerated. Within this category will come all the benefits resulting from coöperation and community effort. Shipping and storage facilities, sales organizations and availability of skilled labor may be mentioned as largely dependent on the state of regional development. Buyers are attracted to the regions where fruit may be purchased in considerable quantities. The reputation of a region for shipping high class fruit has much to do with the selling price of the individual's crop. Western New York, Shenandoah and Hood River are names which immediately summon to the buyer's mind a fairly well defined idea of the quality and variety of apples grown in each respective region. The difficulties in keeping an orchard free from pests and diseases are greatly increased in a community where neglected orchards abound. Furthermore, if the region has the reputation of shipping rather poor quality fruit, the grower will encounter an inherent prejudice against all fruit from that particular section.

Soil.

No other item should receive more careful consideration in choosing a fruit-farm than the question of soil. Soil requirements for the apple vary somewhat with the variety, but practically all authorities agree that a deep, friable, loamy soil with good water drainage, describes briefly the soil condition to which the apple is best adapted. This

Plate VIII.—*Upper*, Eight-foot disk in operation in the Rogue River Valley, Oregon, showing a common method of cultivation. *Lower*, Spring-tooth harrow in use in a northwest orchard. This implement is very generally used where clean cultivation is practiced.

somewhat general description will imply that the apple might find a suitable soil habitat in almost all of our better general farming regions, and this fact is attested by the very wide distribution of apple plantings throughout the United States.

Good drainage and soil depth are prime soil requisites for apple land. Natural drainage is essential since the apple tree does not thrive with wet feet. A subsoil depth of at least six or eight feet is necessary to insure proper root development and a sufficiently large water reservoir. The presence of hardpan, ledges of rock, or similar strata, within a few feet of the surface tends to obstruct root growth and the capillary movement of soil-moisture, and for this reason is highly undesirable, if not prohibitive. Deep-rooted leguminous crops such as alfalfa may remedy soil defects of this nature, while dynamiting tree holes before planting can be depended on to loosen up the subsoil to a greater or less extent. It is much safer, however, to avoid all shallow soils or those with the objectionable subsoil strata. In one widely advertised apple region, dynamiting all tree holes before planting was recommended and universally practiced. All the trees grew well until they attained four or five years of age, at which time the root system began to permeate soils unaffected by the dynamite and the result was a greatly checked growth. It would, therefore, seem advisable to select a soil in which dynamiting is not necessary, although the practice may be beneficial in some instances.

In non-irrigated sections, soil depth has an even greater significance, namely in the conservation of soil-moisture against drought. The importance of an upward movement of moisture by capillarity is well known. If an imperme-

able stratum obstructs this movement, the water-holding capacity of a particular soil may be very greatly reduced. Furthermore, when heavy rains occur in the spring, this same stratum will prevent the downward course of the moisture and cause the condition known as wet feet.

CHAPTER V

THE FARM-MANAGEMENT PHASES OF APPLE-GROWING

The problem confronting the farmer who would produce apples is not alone to raise the fruit successfully. The enterprise must pay, and this depends on many considerations aside from good crops of apples and good markets for them. He must maintain a farm enterprise, or an establishment. What some of these considerations are, we may now discover.

FARM ORGANIZATION IN RELATION TO THE ORCHARD

The relation which the apple orchard bears to other farm enterprises differs greatly in the various states and regions. It varies from a subsidiary or secondary undertaking in many of the eastern states to a highly specialized and major enterprise in the Pacific Northwest regions.

The type of orchard which is fast taking the lead in production of high quality commercial fruit is the specialized planting operated by the individual farmer or his manager. This type is prevalent in the box-apple-producing sections and is also found, to a large extent, in Virginia, northwest Arkansas, parts of western New York, southern Pennsylvania, and many other limited localities. In fact, in all the well-defined commercial areas, the apple orchard is usually the main enterprise on the farm.

There are many obvious advantages in this system. If an orchard is the main enterprise, it will usually be given the care and detailed attention necessary to insure its success as a separate proposition.

However, highly specialized orcharding leaves out two very important points which must be considered — the danger of low prices and the difficulty in employing labor effectively. There is always the possibility of a period of low fruit prices, in which case the old adage "Do not have all your eggs in one basket," holds true. One-crop farming is successful from the standpoint of heavy yields and high quality production, but the average grower or farmer needs an income every year to meet his current expenses. If some year the frost takes his crop or prices are so low as to be below cost of production, he has nothing for his investment or year's labor, and in the case of two or three successive failures, such as have occurred in many sections, it is only the exceptional grower who can survive. Such conditions actually force farmers into diversification. It is much better for a grower to plan originally for a sufficient degree of diversification to insure his living in case of crop failure, for if he is later forced to adjust his business, extra land may not be available and the future of his whole farm organization may be seriously impaired and disrupted. In many cases, orchard enterprises which would have been successful had they been connected with general farms, failed for lack of income in poor years.

Another principal advantage in diversification is that it insures better distribution of labor. Help may be hired and profitably employed by the month or year. In the same way, the owner or operator may engage himself in productive labor on the farm throughout the entire year.

It is important to recognize, however, that the diversified fruit-farm may become so varied that the operator is giving practically all of his attention to other crops and is neglecting the orchard.

In low price years, diversification was urged in the Pacific Northwest and elsewhere, since orchards often did not pay interest on the high-priced land. If the investment is already in the land, it does not follow that apples should not be grown when they do not pay interest on the investment. They may pay a better rate of interest than would any other crop. In sections in which trees are capable of high production, and land is held at such figures as $1,500 to $2,500 an acre, diversification cannot be recommended beyond a limited degree sufficient to provide home garden truck for the family and feed for the work horses. In districts such as Wenatchee and Yakima, the prevailing labor is by the day, employed when needed. This form of employment obviates the necessity for the grower to find work for his men outside of the busy season.

The advantages of a highly specialized and cultivated orchard located in a specialized district are: (1) The assurance that the orchard will be given detailed care and attention since the operator depends directly on it for a living. (2) Labor is likely to be more skilled and more expert if employed only in fruit-growing and not in the cultivation of other crops. (3) Growers are forced to coöperate and work in harmony in order that the fruit may be marketed successfully. (4) Standardization is emphasized and encouraged, both in scientific methods of management and in handling and putting up the fruit for the market. (5) The best varieties survive and the poor ones are soon eliminated under keen competition. (6)

The specialist is nearly always more thorough, more efficient, and produces a better quality of product.

The outstanding advantages of a modified system of diversified farming, with the orchard still the main enterprise, are: (1) There is an assurance of more profitable distribution of labor throughout the season. (2) Month labor can usually be employed, thus effecting considerable saving in labor rates, and insuring a constant supply. With a specialized orchard, unless it is very large, only day labor may be employed profitably. (3) The grower is protected against years of poor fruit prices by having sufficient crops and diversification to insure a living. (4) When live-stock is kept on farms, a part of the manure thus produced may be used to build up the fertility of the orchard. (5) The orchard is a long-time investment, and unless supported by a diversified farm requires much capital to bring to full bearing age and productivity.

Many instances might be cited to emphasize the importance of diversification in connection with fruit-growing. Ninety-nine mortgages are said to have been foreclosed in a certain western fruit district in one day. These failures resulted from paying a high price for land when the purchaser had insufficient capital to wait for the orchard to come into profitable bearing. Low prices for fruit added to the number of failures. Much the same occurred in several districts, particularly in the Rogue River Valley, Oregon, Grand Valley, Colorado, the Bitter Root Valley, Montana, and parts of Idaho and Washington. These failures were in most cases due to false advertising stating that fortunes were to be made in the apple business with profitable crops when the trees were five years

old. These failures do not necessarily argue against the regions themselves but against specialized farming with too little capital in sections not adapted to that type of enterprise.

The Bitter Root Valley, Montana, one of the finest general farming, grain and stock localities, is hardly adapted to specialized fruit-growing. Of localities in the United States probably best adapted to high specialization in apples are the Wenatchee and Yakima valleys, Washington, Hood River Valley, Oregon, and Pajaro Valley, California. There are sections in the East where specialized apple-growing may be justified even to the extent of ignoring all other types of farming. However, it must be conceded that some diversification is usually advisable for the man with limited capital.

A third type of farm organization is common in non-commercial districts, and even in the heart of such commercial regions in New York and the central west states. This third type is seen on the general farm where the orchard is of secondary importance, too large for a family or home orchard, yet too small and poorly cultivated to be classed as commercial. In practice, orchards, when made a secondary or an incidental enterprise, are seldom a financial success. When orchards of this type are eliminated or put on a first-class commercial basis, the commercial industry of the Central West and East will assume new vigor. Production will be more standardized and will enable eastern growers to hold their markets against fruit from other regions.

Semi-commercial orchards of this type, partly or wholly neglected, occur on thousands of farms in the East to-day. A visit to Genesee or Oswego County, New York, will

reveal striking illustrations of such conditions. Genesee County is interested in potatoes and beans; Oswego in growing pears, dairying, and other kinds of farming. In these counties the average orchard is decidedly a side-line. Some of the orchards might be renovated profitably but this is only advisable when the owners intend to give their trees continual attention. It is impossible to produce strictly commercial fruit if careless methods are employed. A neglected orchard which is not a source of profit should be cut down rather than be allowed to breed disease and insect pests to attack good trees in the neighborhood. The semi-commercial orchard was the prevailing type in the past but it is rapidly giving way under competition.

The family orchard need not be discussed here, other than to say that it fits in well with nearly any farm organization. It serves an entirely different purpose and is not considered from a purely profit-making standpoint.

The fourth type of farm organization to be discussed in relation to apple-growing is the stock company or corporation. It is often spoken of as "syndicate farming." Much depends on the motive behind such corporations. As a rule, they are merely stock-selling schemes. The record of such organizations in various parts of the country has been one of conspicuous failures, particularly with those which capitalized orchard land at so much an acre in an endeavor to sell stock or bonds to a large number of investors. This type of promotion lends itself to fraud and misrepresentation since it flourishes in times of prosperity and in good fruit years when profits are large. Glittering prospects are held out to investors and appeals are made to a class of persons unfamiliar with

any type of farming. Fruit-growing is essentially a specialized one-man enterprise.

Following are listed some of the advantages and disadvantages of so-called "syndicate farming" where the organization is legitimate and well managed:

Advantages: (1) Economy in the purchase of supplies; (2) possibility for more effective marketing of the produce; (3) improved standardization of grade and pack.

Disadvantages: (1) Possibility that overhead in the way of salaries and other expenses will become excessive and disastrous in poor years. The farmer can retrench but fixed and overhead expenses of a syndicate are not easily lowered. (2) Lack of personal interest in supervision and labor. Farming is not comparable with manufacturing plants in this respect. There can not be the organization and division of labor as in a factory. In an orchard, men are being constantly shifted from one task to another with the accompanying tendency to saunter. The hired employee is more wasteful of material and careless with equipment if not immediately supervised by the owner. (3) The possibilities of greatly increasing production in order to meet expensive overhead are limited. A frost may offset the most scientific and carefully prepared program.

Syndicate farming sounds plausible but seldom works out. If land is purchased at reasonable figures, very often profit is made on increased values. As a type of farm organization, however, it has not been precedented with general success.

The foregoing discussion relating to farm organization must of necessity apply to average conditions and to

the average individual. The individual must adapt the organization of his plans to the economic conditions as they exist in his particular community. He must take advantage of the favorable conditions in order to combat the unfavorable ones. It must be recognized that commercial orcharding is seldom successful as a side-line enterprise and, while it is important that there should be diversification in order to provide some outside income, the orchard should always remain a leading if not specialized undertaking.

SYSTEMS OF TENANTRY

The problem of renting enters less into the apple-growing industry than into almost any other type of farming. It is seldom profitable to entrust the care of an orchard to the tenant system and this has discouraged the practice of renting among the owners of fruit-land generally. In years of crop failure, the tenant will not and can not be expected to devote himself to the intense care which might result in a profitable crop after his lease has expired. Obviously a long-term lease with detailed specifications as to the number and character of sprays to be applied, the amount of pruning and cultivation to be given, and a complete understanding as to the harvesting methods, would have many advantages over a short-time lease. And yet even with such specifications, it is almost impossible to secure the personal attention which is the secret of success.

The basis for renting apple orchards depends largely on the individual orchard and also varies considerably in different regions. A system in which the owner has supervision is obviously desirable from the owner's standpoint. A number of systems of tenantry will be discussed briefly.

SYSTEM I.

Renter furnishes:	Owner furnishes:
1. Half of all labor and material costs.	1. Half of all labor and material costs.
2. Half of all equipment and live-stock.	2. Half of all equipment and live-stock.
	3. Dwelling for tenant.
Renter takes:	**Owner takes:**
1. One-third of packed fruit.	1. Two-thirds of packed fruit.

Under the above system, the owner and tenant enter into a straight partnership to operate the fruit-farm, first setting aside one-third of the packed fruit to go to the owner for rental on his farm. When the tenant works alone he receives half wages. If one additional man is needed, his services are paid for by the owner to offset the labor of the tenant. Under this plan a desirable man with little capital would be able to get a start, while the owner would be protected by having a direct voice in the operation of his orchard.

SYSTEM II.

Renter furnishes:	Owner furnishes:
1. All labor, material, and equipment with the exception of fertilizer and material for the winter spray.	1. Farm and suitable dwelling.
2. One-half of the barrels or boxes.	2. All of the fertilizer and material for the winter spray.
	3. One-half of the barrels or boxes.
Renter takes:	**Owner takes:**
1. Half of packed fruit and delivers the other half to the warehouse.	1. Half of the packed fruit.

In western New York where very often the orchard is only one of several enterprises on a general farm, the above system of tenantry is common. Under this system the owner exercises an appreciable, yet less far-reaching influence in the management of his orchard than under

plan No. I. The second plan affords the owner an attractive contract, since it gives to him a large part of the crop with little cash outlay. On the whole, the system is fairly equitable, although in years of low prices the tenant might be put at a relative disadvantage. The owner furnishes the fertilizer, since that is somewhat in the nature of a permanent improvement. He also furnishes material for winter spray, an expensive item which the tenant could ill afford to bear in years of total crop failure, and yet one which the owner cannot venture to omit if he values the vigor of his trees.

System III.

Renter furnishes:	Owner furnishes:
1. All labor, material, and equipment.	1. Farm and suitable dwelling.
Renter takes:	**Owner takes:**
1. Three-fifths of crop.	1. Two-fifths of crop, delivered in town and packed out in barrels.

System IV.

Renter furnishes:	Owner furnishes:
1. Equipment, all labor and material costs up to harvest.	1. Farm and suitable dwelling.
2. Labor and material costs for picking, packing and handling one-half of the fruit.	2. One-half of picking labor.
Renter takes:	**Owner takes:**
1. One-half of picked fruit, packs and handles it according to his own judgment.	1. One-half of picked fruit, packs and handles it according to his own judgment.

Under the above system, the owner is allowed the privilege of grading and packing out his own fruit while the same privilege is reserved for the tenant. A modified

form of the above is seen when the owner furnishes half of the picking labor and half of all labor and material costs incident to the harvesting of the fruit, taking one-half of the crop, but allowing the tenant entire supervision of the orchard operations.

A study of an equitable basis for tenantry has revealed that when the tenant is furnishing all the labor he is entitled to a larger proportion of the crop in years of exceedingly heavy production. Otherwise the owner reaps practically all the benefits of a large crop. Unfortunately, low prices prevail in heavy crop years. With straight share rentals in such years, the owner obtains a large amount of fruit which even at low prices makes good returns. If the tenant, however, receives low prices for his fruit, he has insufficient margin to cover the heavy expenditure in harvesting the landlord's portion of the crop. Some division of the labor and handling costs at harvest time would seem more equitable.

Occasionally a long-term cash lease at a reasonable figure can be secured on somewhat run-down orchards in a favorable locality. Frequently such an orchard is making little or no returns and a cash offer will be attractive to the owner. For the experienced man with little capital, a long-term lease with a view to building up and increasing the yields from such an orchard sometimes proves a profitable venture, particularly when the owner considers that his orchard will be improved and for such a reason grants an otherwise low cash rental figure. Some special inducement must be offered to a tenant, otherwise he can not afford to devote his best energy towards building up a successful orchard from which another will reap the ultimate reward.

CHAPTER VI

ESTABLISHING THE APPLE ORCHARD

THOROUGH preparation of the land before planting is exceedingly important if the apple orchard is to be well established. Very often orchards are planted on pasture, timbered, or sage-brush land where the soil has been untilled. Timbered land, once cleared of stumps and brush, usually lends itself well to early planting because of an abundance of humus available for young trees. It is best in nearly all cases, however, to anticipate planting by a year or two in order thoroughly to subjugate the soil by the growing of tilled or cover-crops. Soils which have been depleted in fertility or which are low in humus-content may be built up by the growing of such legumes as alfalfa or clover. In the case of arid or sage-brush lands reclaimed for irrigation, the soil is usually low in humus-content. In such instances the growing of alfalfa for one or two seasons will usually repay the orchardist for delay in planting.

Deep plowing should precede planting in every case, for once the trees are established, deep cultivation is likely to injure the rooting system. Dynamiting is sometimes recommended when a hardpan or thin stratum of rock occurs near the surface, but ordinarily this practice is not to be advised and such soils should be avoided. When spring planting is to be employed, fall plowing is recom-

mended, since it exposes the soil to the ameliorating influences of the winter and causes the destruction of many insect pests and rodents. In the case of sod land, it is best to plow and cross-plow in the fall, leaving the land rough throughout the winter, working it up thoroughly with the disc and harrow the following spring. When cover-crops are grown to improve the soil, plowing is usually deferred from fall until spring.

Land which is to be irrigated should be leveled and carefully laid off with irrigation ditches prior to planting, since it is not easy to effect changes in the contour once trees have been set.

NURSERY STOCK

Apple trees are propagated either by grafting or budding, the former being the most common method. No attempt will be made to discuss methods of propagation since it is usually advisable for the orchardist to buy his trees from a reliable nurseryman rather than to propagate them himself.

The purchase of nursery stock should receive most careful attention. The grower should consult with state or government horticulturists or with successful growers in order to establish the integrity of the firm with which he proposes to deal. The orchardist should buy only the best trees, dealing directly with the nursery and avoiding tree peddlers. The purchase of inferior stock is always poor economy.

All horticulturists do not agree as to the proper age of trees to plant. However, the one-year whip is usually most desirable, since it can be trained properly and has

more fibrous roots. Trees older than one year are often poorly shaped.

It is advisable to purchase nursery stock well in advance of planting in order than one may secure stock of desired variety and quality. If trees are to be planted in the spring, they may be purchased safely in the preceding fall and "heeled-in" by the grower himself. On arrival, all trees should be carefully inspected for disease, attention being given particularly to infestation of scale or woolly aphis, or the presence of crown-gall. If possible, a competent inspector should pass on the stock to see that the trees are healthy, vigorous, and of smooth bright bark. One-year old whips should be about 5 feet tall and 3/4 inch in diameter at the base.

The subject of varieties is thoroughly discussed in Chapter XIX. Selection should be confined to three or four standard varieties for commercial planting.

Immediately on arrival, all trees should either be planted or "heeled-in." If trees arrive in freezing weather, they should be left in the original package and kept in a cool damp place until thawed out. Ordinarily, however, the grower should avoid leaving the trees in the original package lest they become seriously injured or entirely worthless from drying out.

When planting is not to be done immediately, the bundles should be cut open and the trees unpacked and "heeled-in" singly. Too much emphasis can not be placed on the importance of "heeling-in" the trees on their arrival. In this operation, a trench is dug about 18 inches deep and the trees placed in the trench with their tops slanting to the south at an angle of about 45 degrees. Moist soil should be carefully worked in about the roots of

the trees so that they will not dry out. Care must be taken in order that the varieties will not become mixed.

SYSTEMS OF PLANTING (FIG. 2)

The following are the three best-known planting systems:

(1) In the square planting system, the rows run at right angles and the trees are the same distance apart each way. This method facilitates cultivation, spraying, harvesting, and other cultural operations.

(2) In the hexagonal system the trees are equally distant in every direction, being set in equilateral triangles or alternate rows, so that the space between each group of four trees is diamond-shaped. The hexagonal system does not lend itself well to the use of fillers, but since all the trees are equidistant there is an equal distribution of air, light and soil. This system provides for about 15 per cent more trees to the acre than could be planted on the square plan at the same planting distance.

(3) With the quincunx system, the trees are set in squares with a tree in the center. This latter plan is adapted to plantings where fillers are used, it being possible to remove the tree in the center of the square without disturbing the permanent planting system.

The symmetry of the orchard depends to a large extent on the evenness of the rows. When a large orchard is being set, it may pay to employ the use of a transit so that the trees may be spaced with utmost accuracy. This is not absolutely necessary, however, since more simple methods may be practiced, particularly with more limited plantings. Whatever system of planting is followed in laying out the orchard, the first trees should be

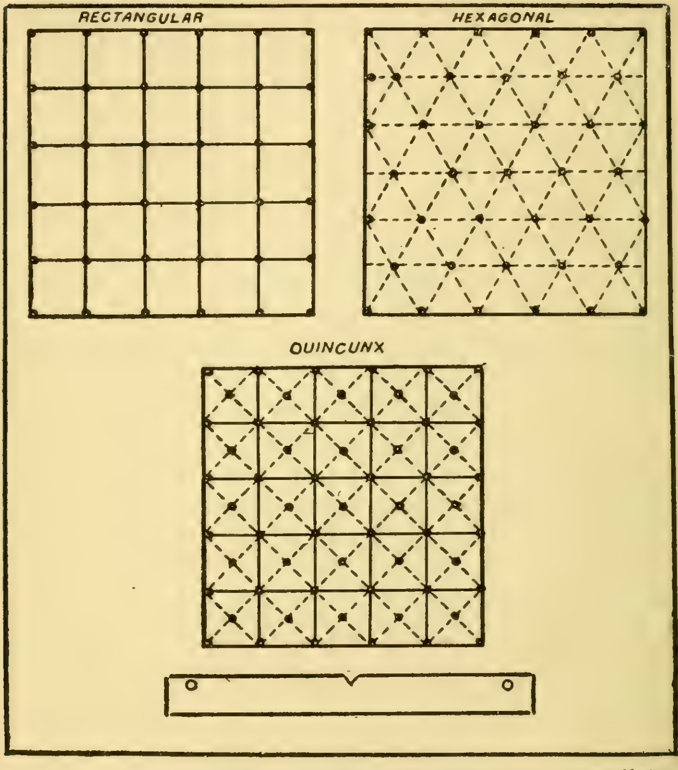


FIG. 2.— The rectangular or square, the hexagonal or equilateral triangle and the quincunx systems of planting. Planting-board of type often used in setting illustrated at bottom of figure.

from 20 to 25 feet from the fence in order to afford room for turning a team or tractor engaged in orchard operations.

Square system.

By laying off the base line parallel with the fence on one side of the field and by placing stakes at regular in-

tervals in this line, it will be possible to establish the position of the trees in this first row. By establishing another line at right angles to the first, it will be possible with the use of stakes to sight across and establish parallel lines which will serve as guides in lining up the rows. It is usually advisable to set a stake at the place for each tree. Then after sighting across from the base lines, it will be possible to determine the stakes which are not in alignment. Figure 2 shows the three important systems for laying out commercial plantings. Table VIII indicates the number of trees to the acre under different planting distances and systems.

TABLE VIII.— NUMBER OF TREES TO THE ACRE

Distance Apart	Square	Hexagonal	Quincunx
16 x 16	170	196	303
18 x 18	134	154	239
20 x 20	108	124	129
22 x 22	90	104	148
24 x 24	76	87	132
25 x 25	70	80	125
26 x 26	64	74	114
28 x 28	56	64	100
30 x 30	48	55	85
32 x 32	43	49	76
33 x 33	40	46	71
35 x 35	35	41	65
36 x 36	34	39	60
40 x 40	27	32	48
45 x 45	22	25	39

Hexagonal system.

The use of a wire triangle is recommended for planting trees under the hexagonal system. Each side of the triangle should represent the distance between the permanent trees. The wires should be connected at each angle by means of rings. The triangle is then carried about by

three workmen, and if kept tightly drawn and held level, stakes marking the exact site of the trees may be located after the first base line along the side of the orchard has been laid off.

Attention is called to the fact that in laying off planting distances on uneven land, care must be taken in keeping the measuring line level so that the distance between trees does not include the slope of the land.

Quincunx system.

The quincunx being a modification of the square system, may be laid off in the same manner as the latter. The location of the center tree may be established by placing an additional stake midway between the tree stakes in the base line.

PLANTING DISTANCES

Close planting is a common tendency in laying out commercial apple orchards. While planting distances vary with the variety and with the region, it is seldom advisable to space permanent trees closer than 30 feet apart. Spreading trees such as Baldwin, Rhode Island Greening and Arkansas (Black Twig) should be planted at greater distances, not closer than 40 feet apart when growth is vigorous. A great mistake was made in planting New York orchards closer than 40 feet. Varieties such as Wagener, Yellow Transparent, and Twenty Ounce, which have an upright habit of growth, do not require extreme distances and may be planted as close as 30 feet. In regions in which trees attain smaller size, the planting distances of these upright growing trees may be reduced

to 28 or even 25 feet. Orchardists should bear in mind, however, that trees set too close together very seriously handicap orchard operations, for branches interlock when full growth is attained.

TIME TO PLANT

The time of planting depends entirely on local conditions. Fall plantings may offer one distinct advantage if the trees become established before winter sets in and are able to start growth early in the spring. However, if the winter is cold, dry, or otherwise unfavorable, the fall planted trees may be seriously checked in their early growth. For this reason spring planting is preferred in most northern regions. In the southern latitudes, late fall or early winter is usually considered safe.

If there is any question, it is safer to plant in the spring as soon as the soil can be placed in good tilth. Trees should be kept dormant until setting.

SETTING TREES

The use of the planting-board is important in securing perfect alignment. (See Fig. 2.) Such a board is usually 4 or 5 feet long, 6 inches wide and 1 inch thick with a notch in one side at the center and a hole in each end. In using this device, the notch in the center is first placed tightly against the stake which stands where the tree is to be set. Other stakes are then driven through the holes in either end and the board is later removed to permit the digging of the hole. After the hole is dug, the board may be placed over the pins and the tree set so as to occupy the same position in the notch as did the original stake.

A four-man crew is efficient when a large number of trees are to be planted. Holes should be dug large enough to accommodate the root system without crowding or bunching the roots, also sufficiently deep to permit the planting of the tree two or three inches deeper than it stood in the nursery row. It is important that all broken, bruised or interlacing roots be cut away at the time of transplanting. Long roots should be cut back to about six inches. After the tree has been located with the aid of the planting-board, rich soil from the surface should be worked tightly under and among the roots with the fingers. The hole should then be filled about half full of dirt and tramped. Hard lumpy soil should be avoided since it dries out easily. The remainder of the hole should be filled and the earth carefully tamped about the roots. A few shovelfuls of loose dirt or a few forkfuls of loose manure thrown about the tree is a last precaution to prevent the loss of moisture and completes the operation of planting. When strong winds prevail as in many localities, it is important that the tree be leaned strongly against prevailing winds. When large numbers of trees are being planted, the roots should be covered with sawdust or placed in a tub of loamy soil mixed with water. This precaution will prevent drying out of the trees when they are being distributed for planting.

HEADING TREES

In transplanting, a large part of the root system of the young tree is removed. In order to preserve the proper balance between the top and the roots, it is necessary that the former be cut back as severely or even more so than the

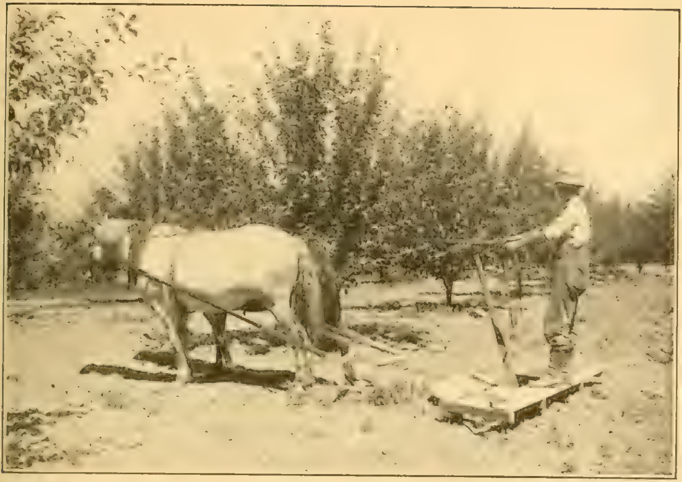


PLATE IX.—*Upper*, Weeder in use in a Hood River orchard. *Lower*, Type of float commonly used at Hood River after cultivation.

root system. Not only does this maintain the proper balance between root and top, but it permits the proper heading of the tree. While no definite height is given for heading, it is suggested that one-year apple whips should be cut to about 24 inches at time of planting in order that the proper shaped trees may be developed. Emphasis is laid on the advantages of low-headed trees. Such operations as spraying, pruning, thinning and harvesting can be done more economically and effectively when the bearing surface is close to the ground.

USE OF FILLERS AND INTER-CROPS

The practice of planting "fillers" to utilize the land between young trees is common and may have the advantage of bringing early returns before the permanent orchard attains bearing. Peaches or early bearing varieties of apples such as the Yellow Transparent are used most commonly as fillers. The grower usually makes the mistake of allowing these temporary trees to remain too long, with the result that the permanent trees are crowded and their productivity jeopardized. If the orchard is favorably situated for the production of peaches, the grower will find that this fruit lends itself well to a system of fillers. Varieties of apples such as McIntosh, Wealthy, Wagener, Duchess and Yellow Transparent, which come into bearing early, are adapted for use as fillers.

The growing of small-fruits between the rows, such as strawberries, blackberries and raspberries, has been very profitable in some regions. Notable among such instances is the Hood River Valley, well known for its strawberries produced as an inter-crop in the young apple orchards.

Cultivated crops such as potatoes and tomatoes may prove profitable as inter-crops, although care must be taken not to encroach on the soil and water requirements of the young trees.

CHAPTER VII

CULTIVATION OF THE ORCHARD

In this chapter will be discussed methods of tillage and systems involving the use of cover-crops and sod-mulch, and the use of the tractor in orchard cultivation.

No hard and fast rules can be laid down for soil management since conditions vary greatly in different regions, but a number of principles should be followed everywhere. Usually the correct system is worked out eventually by the most successful grower in any community and it is by following in a general way methods which by demonstration have established their efficiency that one may hope for the best results.

In reacting from the neglectful practices of soil management which prevailed in many eastern orchards, the western apple-growers for a period of years adopted a program of intensive and absolutely clean cultivation. (See Plate VII.) Conservation of moisture and stimulation of tree growth were the two principal reasons for such a program. Until 1915 absolutely clean cultivation was the practice in all of the leading apple regions of the Pacific Northwest. As the trees grew older, greater demands were made on the soil and it became apparent that this system of soil management led to a depletion of fertility and failed particularly in maintaining the necessary humus-content. A rapid change occurred in the system of soil management and at present a cover- or shade-crop sys-

tem has come into common use. Alfalfa seems best suited to the irrigated orchard land of the West and although it is spoken of there as a cover-crop, it is more properly either an inter-crop or a sod-mulch, for it remains in the orchard for several years and as a rule one or two cuttings are taken off in the form of hay.

CLEAN CULTIVATION

Clean cultivation has many evils which are not at once apparent. The most striking example occurred in the Hood River Valley, Oregon, where clean cultivation was practiced until about 1915 when the bearing orchards began to show marked signs of lack of vigor, evidenced by pale foliage, light yields of small fruit and poor annual growth. The Hood River orchards made a marked recovery in the next two or three years, following wider use of irrigation in growing leguminous cover-crops and on application of nitrate of soda.

Except in special cases, continued clean cultivation can have only disastrous results. Where there is sufficient nitrogen and humus in the soil, there is no particular objection to clean cultivation for a limited period of years. Clean culture for a time unquestionably stimulates tree growth and increases yields. It has been observed that this practice is followed continuously in some of the best paying and finest apple orchards in the United States. Invariably, however, in such instances the original soil was unusually rich in humus and other plant-food and this reservoir has not been exhausted. It is better to maintain fertility, for once depleted its restoration is difficult.

In starting young orchards, clean cultivation is not harmful for the first three or four years. In fact, it may

be very beneficial and is probably advisable when intercrops are not particularly profitable. In certain seasons and in certain regions, lack of sufficient moisture is a critical factor. Obviously the only method to follow in dry years is to practice intensive cultivation in order to preserve the soil-mulch so necessary for moisture conservation. Ordinarily regions in which such an extreme shortage of moisture might take place would hardly be recommended for apples, although dry years are likely to occur in almost every section.

When clean cultivation is practiced, humus should be supplied. Barnyard manure, when available, is the most suitable form, since it not only supplies humus but nitrogen and other elements of plant-food as well. Straw, shredded cow fodder, or stubble clippings when scattered under trees and incorporated in the soil, increase the humus-content. Applications of the latter materials at the rate of 50 to 75 pounds each for trees under six years and from 75 to 150 pounds each for trees six to ten years will prove beneficial.

SOD- OR GRASS-MULCH

Many apple orchards of the United States are allowed to remain in sod- or grass-mulch. The sod-mulch system offers the line of least resistance and represents the least expenditure of time and effort. It is particularly common throughout eastern and middle west orchards. Its possible advantages are: (1) increased color of fruit; (2) reduced cost an acre; (3) prevents hilly or mountainous soils from washing.

The sod-mulch is probably the only practicable system for certain hilly districts in New England and throughout the Piedmont region in Virginia where the orchard land

is too steep to cultivate and where clean cultivation would result in bad washing. The natural vegetative growth supplemented by fertilization in some instances and occasional cultivation about trees serves to maintain the fertility of these soils.

The disadvantages of the sod-mulch system are: (1) reduces yields; (2) reduces vitality and tree growth; (3) provides harbor for mice, insects and diseases; (4) has tendency to encourage general neglect; (5) reduces soil aëration; (6) sheds rain.

In all cost-production studies, the question of yield appears as the critical factor. It is not the acre cost of operation, but the barrel or box cost of production that determines profit. If the yield can be increased, the cost of production is usually materially decreased. Records taken by the writers show that in general yields are reduced under the sod-mulch system.

While the sod-mulch may be depended on to return humus to the soil and commercial fertilizer may maintain fertility, the lack of cultivation will undoubtedly be felt, and as a general rule trees in sod-mulch have less vitality and make less growth than those which are cultivated.

Some growers, notably one very successful grower in western New York and many in southern Ohio, use the sod-mulch system very profitably. It can not be condemned under all conditions but it unquestionably tends to encourage general neglect of the orchard. The grower with the sod orchard is not brought into such intimate touch with his trees as the one who practices more intensive culture and who is working about among his trees every few days. Furthermore, the sod furnishes a harbor for mice, insects and diseases.

CLEAN CULTIVATION WITH COVER-CROPS

The best general method of soil management for all commercial apple regions, with two possible exceptions, is clean cultivation with the use of a cover-crop. The two general exceptions are: (1) western irrigated orchards which at present are committed largely to the system of leguminous inter-crop or perennial cover-crop; and (2) orchards which are too hilly to permit of cultivation, such as have been described for parts of New England and Virginia.

The term "cover-crop" is correctly applied to a crop sown in the late summer months, usually in July or August, which is plowed under the following spring. By cultivating the orchard until late summer, the grower is using the best method for conserving the moisture and is insuring other benefits to be derived from cultivation.

In sowing the cover-crop in the summer or fall, the orchardist can check the growth of his trees and insure the hardening of their growth before winter without robbing them of the plant-food necessary to mature the crop. The cover-crop acts as a protection during the winter months and when plowed under in the spring increases the supply of humus, improves the physical condition of the soil and makes more plant-food available. This system of soil management is most common in western New York where mammoth red clover and vetch are the best suited leguminous cover-crops and rye, buckwheat, oats, barley, rape and cow-horn turnips are the widely grown non-leguminous cover-crops. Leguminous cover-crops are usually more desirable since they not only add humus, but make more nitrogen available.

By combining cover-crops with cultivation, it is possible to secure nearly all of the benefits to be derived from the varying methods of soil treatment. Such a system is designed to preserve and promote permanent soil fertility.

COVER-CROPS

There are two important kinds of cover-crops: (1) leguminous, such as alfalfa, clover, peas, vetch and beans; (2) non-leguminous, such as rye, rape and buckwheat. These crops may be further subdivided into those which live over the winter, such as clover, vetch and rye, and those like rape, buckwheat and peas which die down in the fall. Leguminous crops are recommended at least once in three years or more often, especially when trees are not making sufficient annual growth and when foliage is pale. As a general rule, they are preferable to non-leguminous crops since they add nitrogen to the soil. Cover-crops which live through the winter protect the trees against winter-injury in the absence of snow and also prevent the washing and leaching of soluble plant-foods.

Alfalfa is by far the most popular cover-crop in western irrigated orchards where it has largely supplanted the clean culture system. Vetch, clover and other cover-crops are also recommended. Although alfalfa is known in the West as a cover-crop, a distinction should be made between the eastern cover-crop planted in the fall and plowed under the following spring and the western cover-crop which is left in the orchard for several years. In reality the western cover-crop is an inter-crop, but since its purpose is primarily to benefit the orchard rather than to provide immediate returns to the grower, the word cover-crop has been retained.

The benefits of a leguminous cover-crop as grown in the West (alfalfa most common) are as follows: (1) supplies nitrogen and humus — both limiting factors in the western desert soils which have been reclaimed by irrigation; (2) is thought to have beneficial effect in controlling apple-rosette, a physiological disease somewhat common in the West; (3) provides a source of income — usually two cuttings of hay are removed, the third being left. Whether this is the best practice remains to be proved. Some investigators maintain that the taking of two cuttings of hay removes too much nitrogen. Much depends on what disposition is made of the hay: whether it is fed and returned in form of manure or sold off the farm; (4) improves texture of soil; (5) promotes aëration of subsoil after plants are killed and the roots decay; (6) permits of deeper penetration of the roots.

Disadvantages of leguminous shade-crop system may be summed up as follows: (1) shade-crops may rob trees of water and other plant-food; alfalfa is particularly a close feeder, likely to crowd young trees; it should be grown only where water supply is ample and strip cultivation is practiced among young trees; (2) alfalfa if once started is difficult to eradicate; (3) in some regions, particularly in the East, alfalfa is costly and difficult to start.

With alfalfa as a perennial cover-crop, soil management includes a thorough discing in the spring. Time of seeding varies with the region and should follow established precedent. In passing from clean cultivation to shade crops, the western apple-grower may swerve to the other extreme and allow alfalfa or other crops to remain in his orchard too long. Clover lends itself to short rotations better than alfalfa, although it is less profitable. In any

event, shade-crops should seldom be allowed to remain more than four or five years. Cultivation for a year or two will preserve a judicial balance.

The quantity of seed to the acre for cover-crops may vary somewhat with the region. However, the following table will serve as a rough guide:

Table IX.— Quantity of Seed to the Acre

Mammoth clover	10	pounds
Common red clover	10	"
Alsike clover	8	"
Crimson clover	15	"
Alfalfa	20	"
Cowpeas	75	"
Soybeans	75	"
Hairy or winter vetch	50	"
Summer vetch	60	"
Canada peas	90	"
Rye	75	"
Buckwheat	60	"
Rape	6	"
Turnips	1	pound

VALUE OF CULTIVATION AND METHODS

The philosophy of tillage and its absolute necessity in maintaining soil fertility need as much emphasis in apple-growing as in any other phase of agriculture. Above all, tillage is the principal determining factor in moisture conservation. It increases the availability of plant-food by promoting the decomposition of organic matter; it fines the soil and thereby increases the feeding surface for the roots and it promotes many favorable chemical and biological activities.

Hard, lumpy, untilled soil will no more produce profitable apple trees than any other crop. The bad effects of continued clean cultivation have been emphasized, but the

entire omission of tillage will be even more injurious than too much cultivation.

Plowing every year or every other year is highly recommended for all orchards except those in shade-crops or on land unsuited for cultivation. The operation may be performed either in the fall or spring. The only danger in plowing is too great disturbance of root systems. For that reason regular plowing is more advisable than plowing at intervals of several years. Most commercial apple-growers plow from 4 to 6 inches deep. The general use of cover-crops makes spring plowing more common. Very often discing is the first operation in the spring since it may be done earlier than plowing. When clover or alfalfa is grown in the orchard, plowing may not be advisable oftener than every three years.

Early cultivation is essential to moisture conservation and the soil should be worked as early in the spring as possible. When water is not a critical factor and when a cover-crop is grown, it is sometimes permissible to allow the cover-crop to get a good start in the spring before turning it under. In plowing, the orchardist should plow toward the tree one year and away from the tree in the next in order to prevent the tendency toward ridging. As stated above, when perennial shade-crops such as alfalfa are being grown, plowing of course is not practiced. A thorough discing in the spring is recommended, however, for shade-crops and may take the place of plowing. (See Plate VIII.)

After the first discing or plowing, frequent cultivation, preferably every two weeks, is the program followed by most successful apple-growers. By preserving a soil-mulch until August, the critical drought period usually

Table X

Soil Management Chart for Bearing Apple Orchards

Clean Cultivation.	Sod- and Grass-Mulch.	Clean Cultivation with Cover-Crop.	Perennial Cover-Crop.	Inter-Crop.
Only when moisture supply is insufficient to support cover-crop. Humus and other plant-food must be supplied by application of manure or commercial fertilizer. For periods of a few years in rich soils. At one time practiced widely in the West.	Only for orchards in mountainous or hilly country where tillage is impracticable and where severe washing would occur. Practiced with more or less success in isolated instances under peculiar local conditions. Practiced widely in Middle West, Ohio, parts of New York, New England and in Piedmont region of Virginia.	Best general method. Clean cultivation until July or August, then clover, vetch, peas or soybeans if nitrogen is required and rye, rape or buckwheat if only humus is required. This method provides for conservation of moisture at the critical season. Widely practiced in western New York and Middle West, also in the Shenandoah-Cumberland region of Pennsylvania, Maryland, West Virginia, Virginia, and in New Jersey.	Alfalfa and clover for bearing orchards in irrigated sections, primarily to improve soil, but secondarily to provide one or two cuttings of hay, the remainder being incorporated in soil. Most common system in western irrigated orchards.	Peach and pear fillers to be removed when interfering with the growth of apple trees. Small-fruits or truck crops in strips not closer than six feet from young tree. Widely practiced in South, but not confined to any particular region.

can be passed successfully. By that time it is difficult to cultivate among laden trees. Furthermore, cover-crops are usually sown in July and August and as early as June.

The various soil management systems are summed up in Table X.

IMPLEMENTS (PLATE IX)

Various tools are employed by the successful apple-grower. For plowing, a twelve- to fourteen-inch plow, either single or with two or more bottoms, is a necessary part of orchard equipment. For stony land the spade disc is popular, although the cutaway is more generally used. For late cultivation, various tools are employed. Spike and spring-tooth harrows, drags and weeders of various description are commonly utilized. In the West a light spring-tooth harrow is very popular. The latter is an excellent tool, stirs the soil well, and has many advantages. Clod-mashers, drags or harrows may be equally effective in pulverizing the soil. Special care and precaution should be taken in working among trees to prevent injury.

THE TRACTOR IN THE APPLE ORCHARD

While the tractor has grown rapidly in popularity, usefulness and value for general farm operations during the past decade, there is probably no other type of farming for which it has proved more universally satisfactory and profitable than for commercial fruit-growing when the acreage is of sufficient size to warrant the investment. There seems no question but that the tractor will eventually be used in nearly all of the large orchards and in fact is being used in a great many to-day. In comparing the efficiency of the tractor with horse labor, the tractor has the following advantages:

1. The tractor does work more rapidly. Cultivation, which comprises the major part of the work for which draft power is required on the fruit-farm, is ordinarily restricted to a comparatively limited period. As a tractor works much more rapidly than a team, the orchard may be thoroughly disced and harrowed in a comparatively short time. The number of acres which a tractor will cover in a day will vary greatly. It depends entirely on the make and horse-power of the tractor, the skill with which it is handled, the amount of turning necessary and the time lost due to breakdowns, and the like. However, on the average, a tractor will till many times the area covered by a team and do it much more thoroughly.

The tractor ordinarily does not move any faster than a team, but it draws a much wider disc, harrow or other tool. A good two-plow tractor will pull an eight-foot double disc at the same rate that a four-horse team will draw an eight-foot single disc. The tractor is, therefore, doing the work of six to eight horses.

2. A maximum of work may be done at rush seasons by use of the tractor. Since certain work must be done within limited periods, there is frequently more or less difficulty in obtaining the necessary help just when it is needed. It is, therefore, desirable that the power plant be large enough to permit one man to do a large amount of work in a day and thereby reduce to a minimum the extra help required. It is difficult to use more than a two-horse team in an orchard, as a larger team usually proves unhandy and unsatisfactory among the trees. In the case of large acreages where no tractor is employed, it is often necessary to keep a large number of men and horses at considerable

expense, in order to permit rapid work in the proper season.

3. The tractor has only overhead expense when not in use, while it is necessary to keep and feed horses whether or not they are working. Interest and depreciation on the tractor, however, are no small items of expense. If the whole farm is in orchard, a larger percentage of the draft work can be done with the tractor than is usually the case on general farms. When the orchardist buys a tractor, he can dispose of a larger percentage of his horses than can the general farmer.

4. The tractor permits thorough work. Since the tractor has so much more motive power than a team, it can draw tools which will cultivate much more deeply and thoroughly. When thorough and deep discing is desired, tractors are particularly advantageous. Many tractors draw both a disc and harrow at the same time, the disc following the harrow or vice versa as the grower may desire. This is not feasible when a two-horse team is used.

5. Less injury is caused the trees with tractor. There is a greater danger of injuring the fruit on the lower limbs in cultivating with teams than with tractors. Fruit-growers who have used the tractor emphasize that it may not only be more economical in cultivation, but that it is superior to horses for work in large orchards. They claim that the tractor does less damage to the branches and trees than horses, partly because fewer trips are required to accomplish a given amount of work and partly because the greater width of the implement pulled by the tractor makes it unnecessary to travel as close to the trees as when horses are used.

6. A tractor may work close to trees. The tractor can easily cultivate close to the tree row. In many cases practically all the work of cultivation can be done when the tractor travels in the center of the row. It is sometimes necessary that the motive power, whether horses or tractor, must pass under the limbs and close to the trees, but even in such cases the tractor does considerably less damage than horses. A suitable type of tractor is not as high as horses and furthermore may be equipped with guards to raise the limbs gently while the machine passes underneath without breaking the limbs or jarring off the fruit.

7. The tractor may be useful in doing other work than cultivating. The usefulness of the tractor in many orchards is not confined to cultivation. Growers who have used tractors state that they save much time and expense in pulling out trees which need to be removed because of disease or crowding. A medium-sized tractor will pull most trees without difficulty if a chain is fastened well up on the stump or on some of the heavy limbs and then hitched to the tractor. Some growers use the tractor in the orchard for hauling manure, lime, spray materials, and the like, and in rare cases the spray outfit. While the full possibilities of the tractor have not been realized, it must be remembered that if there are idle horses on the farm it will not usually be profitable to employ the tractor for work which two or three horses could do.

Tractors have proved popular and highly profitable with most orchardists who have used them. It is well to state, however, that there are some disadvantages which many growers have found and which should be given fully as much weight as the advantages.

1. The tractor is feasible only on a large farm. An

ordinary tractor at present is not adapted for use on the small farm, particularly a small intensive fruit-farm. It is not necessary that the orchard be large, but if the fruit acreage is small a tractor will not be profitable unless considerable general farm land is being operated in conjunction with the orchard. Orchards of less than 30 to 40 acres, unless connected with a general farm, will hardly warrant the purchase of a tractor at present prices. There should be at least twenty days' work a year for a tractor in order that it may be profitable. Four to 5 acres of plowing or 18 to 20 acres of double discing may be considered a day's work for the average tractor. A two-horse team will plow about 1½ acres a day in the orchard and disc from 6 to 7 acres.

2. A tractor represents a considerable investment. On account of the initial cost of a good tractor, efficiency is necessary if sufficient returns are made to pay such overhead charges as interest, depreciation, upkeep, and the like. A man of limited capital, particularly if he is operating a young orchard from which there is little cash return, is likely to find a tractor a rather heavy burden on his working capital.

3. Experienced labor is necessary to operate and care for a tractor. While the use of such a machine may save the labor of one or two additional men, it is important to realize that the man who operates a tractor should be experienced and have some knowledge of machinery. When traced back to their origin, it has been found that a great number of complaints with reference to the use of tractors are primarily due to the lack of experience and mechanical knowledge on the part of the operator.

4. There is a heavy depreciation when tractors are care-

lessly handled. When an expensive machine is operated by men who have little interest in their work, it will rapidly depreciate in value. Careless handling will ruin a good tractor in a single season or even in a day. It is exceedingly important, therefore, that care should be taken to keep the machine properly oiled, and in good working order.

5. When a tractor gets out of order, considerable time may be lost. Even with experienced operators, breakdowns may occur, and if a part breaks which can not be replaced short of the factory, days may be lost. The principal criticism which many growers have against the tractor is that some part is always breaking and that it requires considerable time and expense for repairs. There is no doubt that the average tractor has given considerable trouble in this regard, especially when handled by inexperienced men.

6. Where the fences are near the trees, turning at the end of the row is rather difficult on account of the wide cultivating implements commonly drawn by a tractor. This is more particularly true of the early tractors than of the modern machines recommended for orchard work. In most cases, if the tractor is properly hitched to the implement, the turn can be made into the next row of trees. It is seldom necessary, however, that the turn be made into the adjoining row, since the work of cultivation can nearly always be carried on just as well by turning into the second or third row each time, following the same method as is frequently used in cultivating corn in order to avoid short turns. Of course in terraced orchards or those planted in irregular rows, this plan can not be followed. There is

nearly always a way to manage the turning if a little ingenuity is exercised.

In conclusion it may be said that the uses of the tractor in fruit-growing have not yet been fully determined or appreciated. At present tractors are being used in some of the larger orchards of the Middle West, Northwest and middle Atlantic states. They are becoming more and more popular in connection with the operation of orchards and on general farms of western New York. It seems only a question of time until the tractor will largely displace the team in cultivating the commercial orchard.

TRUCK

The use of the motor truck in connection with apple-raising is growing in popularity as rapidly as that of the tractor. When long hauls are necessary and the tonnage of fruit is large, the motor truck has found great favor. In general, the use of a truck will be profitable wherever the purchase of a tractor is warranted and in many cases in which a tractor is not profitable.

CHAPTER VIII

IRRIGATION

Irrigation is the process of watering land by artificial means and is widely practiced in the arid and semi-arid apple regions throughout the western states.

The history of irrigation dates from the earliest times. Egyptian and Babylonian records show clearly that irrigation was known several thousand years B. C. Irrigation in America was practiced in prehistoric times by Indian tribes of the Southwest, but the first irrigation by English speaking people of the United States was by the Mormons near Salt Lake City, Utah. Under the guidance of Brigham Young, the Mormons succeeded in turning the waters from the canyons and streams into the desert and first proved the possibilities of western irrigation. The history of the western fruit regions in nearly every case dates from the time that water was put on the land. The Wenatchee district as recently as 1900 was largely a barren desert. Now it is one of the leading apple regions of the world, producing 12,000 cars of box apples in 1919.

Irrigation as a factor in the commercial apple industry of North America is confined to the apple-growing regions west of the Mississippi and the Okanogan district of British Columbia. It is most widely practiced in the Pacific Northwest. Practically all of the Idaho, Washington, Colorado, Utah, New Mexico and much of the

Oregon commercial apple crop is grown under a system of intensive irrigation.

The Hood River Valley of Oregon, while not an arid region, employs irrigation in many of its orchards. The Rogue River or the Medford district in Oregon was formerly a non-irrigated section but continued drought compelled the practice of irrigation when possible. The only important non-irrigated apple regions in the West are the Watsonville and Sebastopol sections of California located within a few miles of the coast.

The irrigated fruit regions differ in many ways from the apple sections of the Central West and East. Some of their most outstanding characteristics are:

1. Compactness. All irrigated fruit districts are very intensive and compact. They are generally confined within a certain limited and well defined area. The typical farms are small and the orchards average only about ten to twenty acres. Often the orchard of one grower borders directly on that of his neighbor, so that the plantings in an irrigated valley appear as one large orchard with but few breaks of land not in trees.

2. Productivity. Orchards in irrigated sections free from frequent frost-injury bear larger annual crops, partly because the water supply is largely under control.

3. Rapid tree growth. Trees in irrigated districts grow very rapidly and attain maturity early. Often trees at ten years of age are practically in full bearing and in many cases even at seven or eight years of age they bear very heavily. Trees in the Wenatchee Valley attain maturity in about one-half the time required for the same varieties in the East.

4. Trees are set close together. The trees in the irri-

gated districts usually will average twice as many to the acre as under the same conditions in the East; that is, a ten-year-old orchard in Wenatchee will have from 80 to 100 trees to the acre, while in New York 40 to 50 trees would be considered sufficient. A fully matured orchard in the northwestern regions will usually contain as many as 75 trees to the acre, while the New York growers claim that 30 trees is sufficient. Thus the trees of the Northwest do not attain such large size although they grow more rapidly and attain maturity more quickly.

5. Trees of the irrigated regions have a shorter life than those under natural or un-irrigated conditions. Although most irrigated sections are as yet young, there are definite evidences that the irrigated orchard is much shorter lived than the eastern plantation. Trees that attain maturity at such an early age under artificial conditions cannot continue to maintain vegetative vigor and health indefinitely. As yet it cannot be said just what the life of an irrigated orchard under good management may be, but from present indications it would seem that thirty years would about mark the life of the average irrigated orchard. It is certain that trees are ordinarily most profitable and at their best under irrigated conditions between the ages of ten and twenty years.

6. Irrigated regions are usually free from fungus. Serious trouble only appears in the semi-irrigated regions like Hood River Valley where the rainfall is as great as that in western New York, but where orchards generally are under irrigation, due to the rainfall coming at the wrong season of the year. There is little fungus difficulty in the famous Yakima and Wenatchee valleys of Washington or in the irrigated districts of Idaho, Colorado, Utah and

PLATE X.— Irrigating five-year old Winesap trees in the Yakima Valley. In young orchards three furrows are often sufficient.

New Mexico. In this connection, however, it might be well to say that the codlin-moth is generally very much more active and difficult to control than under eastern conditions and particularly has this been true of late years.

7. Trees in irrigated regions require detailed care every year. A grower in an irrigated district must pay strict attention to his orchard if it is to survive or he is to secure any profit out of it. It is absolutely necessary that it be irrigated and if this highly important operation is neglected for a single season, the orchard is ruined. Furthermore, if the irrigating is left to inexperienced hands, the trees are likely to be over-irrigated or under-irrigated to such an extent that they will be injured permanently. Great care also is necessary to see that the water is not allowed to stand on the land or applied at the wrong time. Under eastern conditions, none of these things is necessary, so that orchards which have been neglected not for one year but perhaps several, may often be brought back to profitable bearing. This, however, cannot happen in the Northwest. This partly accounts for the fact that the average northwestern grower is as a rule more thorough and scientific than the average eastern grower. The northwestern owner must be thorough or his orchard will not live. The orchard under eastern conditions can usually survive even if somewhat neglected.

8. In irrigated regions the fruit is usually graded, packed, wrapped and boxed very carefully, while apples under non-irrigated conditions, as a general rule, are not graded or packed as carefully and are seldom wrapped. With the exception of California, fruit in non-irrigated regions is not boxed to any great degree. Fruit is never barreled in irrigated regions. It may be said that in 90

per cent of all cases, irrigated regions produce boxed fruit and non-irrigated regions barreled or bulk fruit.

9. Land in irrigated regions is expensive and the fixed costs or overhead charges are high. Bearing orchard land in the Wenatchee Valley is capitalized at nearly $2,000 an acre. In fact, land in bearing orchards in nearly all irrigated districts is valued at $1,000 an acre or more. Furthermore, interest rates in the Northwest, where these irrigated regions are located, are higher than in the East. From 7 to 8 per cent in the Northwest is a common interest rate which growers have to face. Thus it is important to realize that orchards in irrigated districts, even though the acreage is small, are often valued and actually capitalized at a much larger figure than those of the Central West and East which may be from two to three times their acreage.

10. Irrigated districts are as yet somewhat isolated, while non-irrigated localities are close to important markets. The great bulk of the fruit from irrigated regions has to travel from 1,000 to 3,000 miles to market. Only a very high grade of fruit of superior marketable quality can hope to compete successfully with fruit grown in eastern districts. At present the northwestern grower puts his fruit up in such good condition that he can put it on the market in the heart of the barreled producing section and sell it quite readily even if there is great barreled competition. The difficulty of moving the fruit, due to car shortages, has been a drawback to the Northwest fruit industry the past few years.

The above points are important in differentiating between the characteristics of the irrigated and non-irrigated regions of the United States. There are many minor ones, such as systems of orchard management which are

practiced in irrigated regions and which differ somewhat from eastern conditions, but in general the above differences define quite clearly the characteristics of the two types of orcharding.

CHOOSING AN IRRIGATED DISTRICT

Certain points are important to remember when selecting an irrigated district. When the great orchard irrigation projects of the West were widely advertised, men from middle west and eastern farms and cities flocked to the West and bought orchard land indiscriminately. They paid, at first, too much attention to scenery and the advertising pamphlets of the promoters. It did not seem to enter their minds that such things as liability to frost damage, air drainage, priority of water right and the location of the land, as to whether it could be economically irrigated or not, were of great importance. One of the greatest mistakes which early investors made was in locating on land liable to seepage, that is, land on which alkali showed up after a few years of irrigation, caused either by direct irrigation of that particular plot of land or sometimes by the water seeping down from the tracts of land higher up.

The definite points to consider when locating in the irrigated regions are:

1. The history of the region as regards frosts should be studied. Frosts have been the limiting factor in successful production in many parts of Colorado, New Mexico, Utah, and Idaho. More orchardists have failed through frost damage in successive years than from any other single factor affecting production. Certain parts of western Colorado are so liable to frost damage as to render profit-

able fruit-growing impossible. Frosts seem to be very local in these irrigated regions, that is, certain mesas or limited areas are much more liable to damage than others. The most notable example of how important it is to note the liability to frost in these irrigated districts occurs in the Grand Valley. A few miles above the town of Grand Junction is located the town of Palisades, about which is grouped a very intensive and highly specialized peach industry. Palisades lies in a very narrow part of the Grand Valley on either side of which are large cliffs known as the Book Cliffs. These radiate heat during the night which together with better air drainage combine so that frosts in the blooming season are rare. A few miles down the valley and about Grand Junction itself, frosts are so common that fruit-growers have become somewhat discouraged. Peach-growing on this account has been entirely eliminated. Destructive frosts seldom occur in the Wenatchee Valley of Washington and rarely in the Hood River Valley of Oregon. They occur very frequently in most of the irrigated districts of Colorado, New Mexico, Idaho, Utah and Montana and in some of the irrigated sections of Oregon and Washington.

2. Land not liable to seepage should be chosen. In some districts alkali has appeared on the surface of the soil and the trees have lost their vigor and died. Thousands of acres of land have been lost in the Grand Valley of Colorado through this cause alone and many have become bankrupt who started out with the rosiest prospect. Land in trees which has gone to seep is hardly worth trying to reclaim as far as saving the orchard is concerned.

It is extremely important that irrigated lands be well drained so that water cannot stand on them for indefinite

periods. It is also important that these lands lie so that waste water from orchards which may be higher up or nearer the irrigation canal does not continually seep down on to the land at lower levels.

To go fully into a discussion of alkali and the danger and causes of its appearance would require a book in itself. It is sufficient to state here that too great emphasis cannot be placed on the problem of alkali soil and it is very important that the fruit-growers strive to avoid orchard sites where it is present. Enough is known about the liabilities of soils to seep at the present time so that any engineer or topography expert familiar with the particular region should be able to state quite definitely the relative danger in this regard. Narrow valleys are much less liable to be troubled with alkali than the broader and larger valleys. There is no alkali in the Hood River Valley of Oregon and the Wenatchee Valley of Washington and very little in the Yakima Valley.

3. The third important point to be remembered in selecting soil for irrigation is to see that the land can be irrigated economically. In numberless instances, orchards have been set out on land above the main irrigation canal or on land near no canal and dependence put entirely on pumping systems or small private irrigation systems. In many cases orchards irrigated in this way have succeeded; however, in most cases irrigation is so expensive and water has so often been difficult to obtain at the proper time, that in years of poor prices or light crops the grower has not been able to compete with orchards under systematically installed and bonded irrigation systems. In certain limited sections, the annual water rent charge is as high as $25 an acre. This is prohibitive. In most dis-

tricts it is between 50 cents and $2.50 an acre; $1.50 is about the average annual charge. Aside from this, however, the original water right usually costs around $75 an acre under private irrigation projects. Therefore, it is extremely important when purchasing land to see that it can be irrigated economically and that the annual water rent charge is not prohibitive, or if it is necessary to pump the water one should carefully determine whether or not this is feasible. There are of course artesian wells in some of the more southern sections, but as they occur in so few of the fruit districts they hardly enter the discussion here.

4. It is important to consider the priority of water right. It often happens that growers are located at the end of the irrigating system or canal and in cases in which the water supply is scarce they sometimes have insufficient water for their orchards. This has happened sometimes in the Wenatchee Valley of Washington, where growers in the lower part of the valley were insufficiently supplied with water at the critical time. In other valleys of the Northwest, many instances might be cited where the grower has been forced to use the waste water from the orchard of his neighbor in order to secure sufficient to supply his own land. The buyer unacquainted with irrigation and irrigating systems, therefore, should look carefully into the probability of having guaranteed water rights. One year without irrigation in most sections will usually mean the destruction of the trees. There are many other points to be considered, such as the proper slope for easy irrigation.

It is impossible here to enter into the engineering features of irrigation and one should have the advice of a competent engineer in laying out the main laterals.

IRRIGATING THE ORCHARD

In the discussion of orchard irrigation, so many factors enter into the problem, each of which is modified to a great degree, depending on the soil, ages of trees and various other conditions, that no set of rules can be laid down. The three problems to consider in actually irrigating an orchard are: amount of water to apply, when to apply it, and the means of application.

Quantity of water to supply.

When water is abundant, there is always a tendency to over-irrigate. It should be borne in mind that irrigation is only supplemental to natural precipitation and every effort should be made to conserve the natural moisture. Excessive irrigation causes leaching of plant-food and is injurious to the soil. The basis of water distribution is variable. In general it may be said to vary from 35 to 100 acres to a second-foot. Expressed in acre-inches, the average amount used in a year would cover each acre to a depth of about 36 inches. This is augmented by the normal precipitation which in most irrigated districts does not exceed 10 to 12 inches per annum. The common unit, for instance, for water distribution in the Wenatchee Valley is the miner's inch (one-fiftieth of a cubic foot a second). The prevailing rate of distribution in this region is one miner's inch to two acres.

The water requirement of different soils is somewhat variable. With a rich soil the water requirement is relatively low, while with a leached soil it is high. The practice of growing leguminous shade or cover-crops in irrigated orchards (usually alfalfa) has appreciably increased the

water requirements. The Hood River Valley, with an average rainfall of about 35 inches per annum, found irrigation necessary, whenever cover-crops were grown.

Time to irrigate orchards.

In practice, the fruit-grower recognizes the need of applying water by a slight change in the color and rigidity of the foliage. It is unwise to wait until the trees begin to show signs of wilting, since this delay may prove injurious. It is equally unwise to pour on water just because it is available. Over-irrigation should be guarded against.

It is generally thought that the amount of free water in the upper three or four feet of soil should range between 6 to 10 per cent. For the inexperienced, the following simple test is suggested: Soil samples should be taken from a depth of about 3 feet. Measure out 6 pounds and 4 ounces (100 ounces) of soil, expose this to a bright sun for the greater part of a day, and then re-weigh. The number of ounces lost will correspond to the percentage of free water. If the loss is less than 6 ounces the soil probably should be irrigated. More than 10 per cent loss will indicate a super-abundance of water.

Number of applications.

In the Yakima and Wenatchee valleys, the first irrigation is usually given about the first of May, depending on the soil, the slope, and amount of winter rains. A south slope requires water probably two or three weeks earlier than heavy soil or a steep north slope. In Idaho, the first application of water is usually about the first of June, while in Hood River the water is turned on between June first and fifteenth.

Correct timing of the first irrigation is exceedingly important and will depend somewhat on the amount of winter rains. It is thought that early irrigation tends materially to reduce the June drop. If the trees are kept growing vigorously, they will not usually suffer excessive drop. The spraying operations must be considered in relation to the time of irrigation in order that the soil may be sufficiently dry to permit the hauling of the spray outfit. It is desirable that the water supply be continuous rather than intermittent in order that the grower may definitely plan his work and not be kept waiting for water at critical times.

The number of irrigations varies but will average from four to five in a season, being made at intervals of twenty to thirty days. A light sandy soil which is not retentive of moisture must be irrigated every two or three weeks.

There is a noticeable tendency in late irrigations to swell the size of the fruit. This practice detracts from its keeping qualities and flavor. Excessively large apples tend to go down in storage. Heavy late irrigations, furthermore, increase loss from scald and bitter-pit. It is best to irrigate heavily up until about August fifteenth and then gradually taper off. Ordinarily no irrigation should be made after September fifth.

METHODS OF IRRIGATION

Originally water was supplied to the western apple orchards through earthen ditches. With the increasing scarcity of water, there has been a pronounced tendency towards lining the main canals in order to make them water-tight and to install underground piping to distribute water to the highest point in the orchard or along the high-

est ridge. The use of concrete or other underground piping, together with standpipes, for carrying the water to the upper end of the furrows is unquestionably the most efficient system of distribution. Whether such an investment will prove economical depends on the scarcity of water and the returns obtained from the land. The earthen ditch or cheap wooden flume may be the more economical.

The actual application of water to the soil is usually accomplished by means of furrows or rills. The length of the rills ordinarily varies from 200 to 600 feet, depending on the slope and character of the soil. With sandy soils or steep slopes, the rills should be short and narrow at the bottom in order that washing will not occur or over-irrigation of the upper end of the tract at the expense of the lower lands. With gentler slopes and heavy soil, the furrows may be very much longer and also wider at the bottom, in order to promote percolation. The depth of furrows usually varies from four to six inches, although there is a tendency towards deeper rilling, eight inches being recommended by some in order that the first few inches of surface soil may be kept partially dry. When the top of the soil is moist, there is excessive loss through evaporation. If the land is very steep, a very small stream is necessary in order to prevent washing. With light porous soils the furrows are made shallow, narrow at the bottom and relatively close together, the water being run through quickly and under a heavy head of water.

The number of furrows in a tree row varies from two to six, five being the most common. (See Plate X.) The irrigator tries to get the first row within three feet of the tree row and spaces the remaining ones at a distance of

three to four feet apart. Shallow rills require closer spacing. With very young trees, a furrow on either side of the tree row is usually sufficient. This plan is also followed with mature trees where a shortage of water occurs in order to get over as much land as possible. Ordinarily with full bearing trees, the entire surface of the land is watered.

The most common implements for making furrows are the six-foot cultivator, with the three shovels attached and the single shovel plow. The latter implement is frequently used for making the furrows close to the tree rows. A single furrowing during a season usually suffices when the orchards are in alfalfa, although occasionally the orchardist finds it necessary to open up the rills late in the season. Cultivation between irrigations entails the replacing of the rills.

The operation of turning the water on the land is termed a "set." It is usually necessary to make several sets if the orchard is large. The irrigator turns his entire head of water into a few furrows and allows it to run from twelve to seventy-two hours, varying with the type and condition of the soil. The water is allowed to run, until by a slow lateral movement it saturates the soil between the furrows. When the orchardist finds that sufficient saturation has taken place, he turns the water into another portion of the orchard and so on until the entire area is irrigated.

Flooding is practiced in a limited way and under this system the water seeks its own course over a strip usually a few tree rows wide. This practice has been largely superceded by furrowing.

CHAPTER IX

FERTILIZING THE COMMERCIAL APPLE ORCHARD

FERTILIZING is one of the many important orchard operations and one about which much has been said and written, and yet few definite conclusions have been published. Many state experiment stations and individuals have experimented with orchard fertilizing from time to time and much has been written about the values of different systems. In many cases, however, erroneous conclusions have been drawn because of outside influences which intervened to destroy the value of the experiment. For that reason increased or decreased yields have been attributed to the use of certain fertilizers, when as a matter of fact they were due to other causes. As a result of the many contradictory statements published on fertilizing, this important orchard operation is the one practiced least systematically.

The wide difference in soil conditions complicates much of the experimental data on this subject. Means and methods of application practiced in the different regions are also variable. In all experimental reports there are some definite conclusions on which most investigators agree. One point definitely brought out is the great value of such nitrogenous fertilizers as nitrate of soda and stable manure to nearly all orchard sections.

A prominent investigator of orchard fertilization is J. P. Stewart, and long-standing and interesting experiments

have been conducted by the Pennsylvania State College under his direction. The results of his work in general are of great interest and are more applicable to the eastern conditions under which they were obtained. Other important experiments have been made by various state experiment stations, particularly those of Ohio and Oregon. C. I. Lewis and E. J. Kraus of Oregon have offered valuable contributions on this subject. Thorough investigations have been conducted by experiment stations in Ohio, New York, New Hampshire, Virginia, Indiana and other states.

PRESENT PRACTICES IN FERTILIZING

Before discussing the results and conclusions arrived at by these and other investigators, it is of interest to note the general practices followed throughout the different commercial areas and the attitude of the average commercial grower toward fertilizing. It is only within recent years that the grower has given any great degree of attention to this important subject. However, as with spraying, fertilizing is becoming more and more general and necessary. As yet, however, great numbers of growers do not realize its value. Many are content to allow their orchards to bear very small or medium-sized crops when a few dollars expended in the purchase and application of stable manure or commercial fertilizers would greatly increase their returns at a minimum price a barrel or box. It is only a question of time until the fertility of soils will become depleted. It remains, therefore, for the minority of growers, those few who use fertilizer, to convince orchardists generally of the great value and increased profit to be derived from judicious use of various fertilizers.

Throughout the East and Middle West it is rather a common practice to apply stable manure to the orchard. This is particularly the case in western New York where considerable stable manure is available for this purpose, and where its value seems to be appreciated as much or more than in any other section. The value of stable manure is recognized to a greater or less extent in most of the important apple regions of the East and fruit-growers usually apply to their orchards all the manure which is readily available. As yet, however, many growers hesitate to go to any considerable expense in buying manure from the cities in carload lots. In general, those who have adopted the latter practice have found that it is highly profitable.

In the Far West, the practice of using stable manure is not general. The orchards are small, highly intensive and do not permit the keeping of much live-stock. For this reason manure is not readily available. In western orchards the general method of securing nitrogenous fertilizer is by growing leguminous shade and cover-crops. The Hood River region in Oregon has probably used more commercial fertilizer than any other western section.

In the southern Ohio Rome Beauty district, nitrate of soda is employed extensively as an orchard fertilizer. Annual applications vary from 3 to 9 pounds to a tree. Nitrate of soda is used to a greater or less extent in various other eastern districts, but in no section is its application so general as the Rome Beauty district of southern Ohio.

VALUE OF STABLE MANURE

Nearly all growers agree that the beneficial effects of stable manure are apparent in increased tree growth and

fruit production. Stable manure not only supplements the available plant-food, but has the additional advantage of keeping the soil "alive" and of adding to its capacity to conserve moisture. It makes the food already in the soil more available and permits freer circulation of air.

It may be definitely stated that stable manure has given uniformly excellent results in the various commercial districts throughout the country. (Other fertilizers have not been so widely tested.) Annual application of 8 to 10 tons to the acre in a well-managed orchard is usually sufficient to secure good annual crops, although a less amount is very beneficial. Some growers prefer to make heavy applications every three or four years, applying from 25 to 30 tons to the acre, or from 15 to 20 tons every other year. A few New York growers are the most common practitioners of this method. New York orchards with their large and old trees can utilize profitably a very large amount of plant-food.

Careful cost-accounting records taken on about 400 farms in the western New York apple belt show that orchards which are given annual applications of manure, and in which leguminous cover-crops are grown, give the highest annual yields and are the most profitable.

EXPERIMENTS WITH FERTILIZERS

Research work of Kraus and Kraybill.

A discussion of fertilizing would not be complete without a consideration of the work of Kraus and Kraybill, who have made the most exhaustive research investigation regarding the relation of plant vigor to cultivation and nitrogenous fertilizer.

These investigators found that by dividing plants into three groups a certain definite relation is brought out between the nitrogen and carbohydrates present in the different groups. These groups are divided as follows:

Group 1. Those plants which seem to be extremely vigorous but rarely bloom, and if they do bloom, set but little fruit.

Group 2. Those plants which make a very fair growth and seem to be in good vigor, bear very abundantly and produce a large number of clusters, the blossoms of which readily set fruit.

Group 3. Those plants which are less vigorous than the second group, bloom profusely, but set fruit very sparingly.

A chemical analysis of the plants in these groups shows that: (1) those of the first group always contain an abundance of moisture and nitrogenous compounds; (2) those in the second contain a relatively smaller amount of nitrogenous compound as compared with the carbohydrates (sugars and starches); (3) the plants of the third group contain still less of the nitrates and proportionately much more of the carbohydrates than the second group. It is shown rather conclusively from these experiments that there must be a certain mathematical relation between the nitrates and the carbohydrates in order to secure the best results.

The results of these studies directly apply to the apple. Examples of the first group are commonly found in trees from one to seven years of age which have a great abundance of nitrogen as compared with the amount of carbohydrates, such a condition being encouraged by intensive tillage, severe heading of trees or use of nitrogenous fertilizers. As a result, considerable wood growth but little

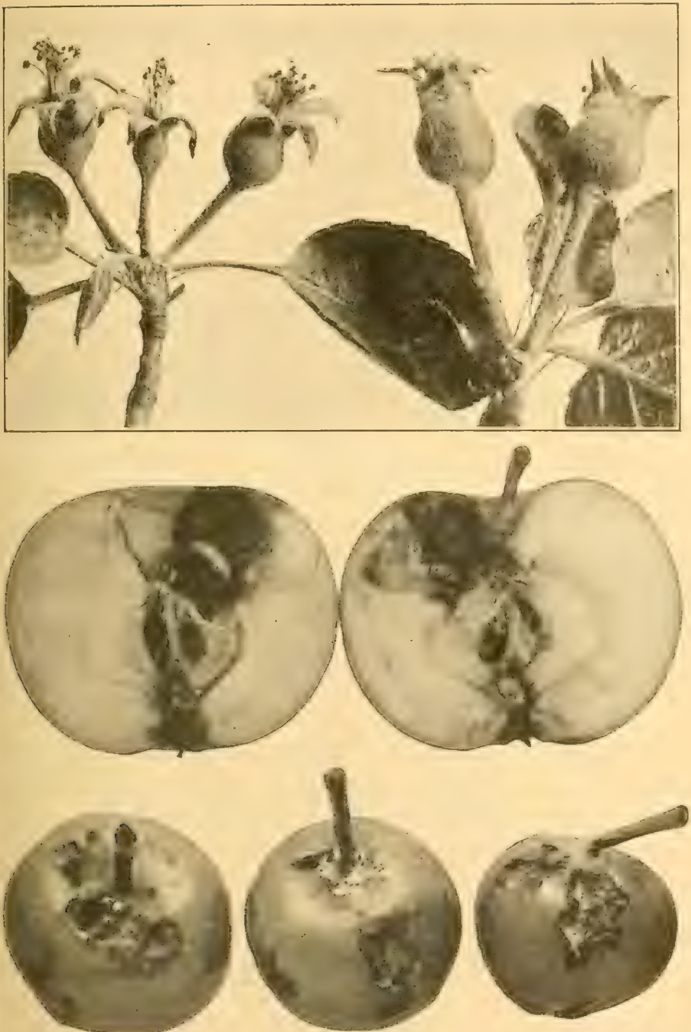


PLATE XI.— Insect pests of the apple. *Upper*, On left, apples in proper condition for first codlin-moth spray; on the right too late for effective spraying. *Middle*, Work of codlin-moth or common apple worm in the apple. *Lower*, Young apples injured by the fruit-tree leaf-roller, an insect prevalent in Fremont County, Colorado, and often in New York and other barreled sections.

fruit is secured. It is found by reducing tillage, pruning and other stimulating operations, that one automatically reduces the relative proportion of raw sap and nitrogen and allows the increased leaf areas to manufacture more concentrated food, such as sugars and starches. As a result, such trees begin to form buds, produce fruit and thereby pass into the second class.

In the third group or class of trees, the nitrates have become much reduced in proportion to the carbohydrates. As a result, the leaves become yellow and thin, the spurs begin to die and the set of fruit is poor. The trees are starving for nitrates amid plenty of sugars and starches. This explains how a relatively small amount of nitrate added in the spring often produces such remarkable results. It once more restores the balance between the carbohydrates and the nitrates. When a proper balance is seemingly reached between these two, the proper vegetative growth and fruitfulness is secured. Such trees then would be classed in Group 2 and, therefore, approach the ideal condition for fruitfulness. Every effort should be made to maintain them in this condition. Good cultivation, the growth of legumes or moderate applications of nitrate of soda will usually serve to maintain the proper balance between the nitrates and carbohydrates. Acid phosphates may also be necessary.

Experiments in Pennsylvania.

In a series of experiments carried out under the direction of J. P. Stewart in Pennsylvania, the following conclusions seemed to be more or less definitely established:

1. It was found that nitrogen, of all food elements, was

the most influential in improving both annual yield and growth.

2. In order to dispel any apprehension of great expense involved in applying nitrate of soda, it may be stated that during a ten-year period nitrate of soda was applied at a cost of 9 cents a bushel of fruit produced, or 27 cents a barrel; and as nitrate was figured at a war time cost of $100 a ton, this shows that even with a very high price the great increase in yield would soon pay for the fertilizer. In these experiments, nitrate of soda was applied at the rate of 4 to 8 pounds to a tree.

[1] 3. "It was found that nitrogen from commercial sources or from stable manure proved more effective than that from cover-crop as a rule." Nitrogen from commercial fertilizers and from stable manure was particularly effective when accompanied with the proper cultural methods.

4. "The addition of phosphorus or potash to nitrogen applications has usually given larger returns than nitrogen alone. The nitrogen and phosphorus combination has produced an average increase over the normal yields in two experiments of 265 and 308 bushels per acre annually during 9- and 10-year periods. This combination is also proving important in one of the experiments in young orchards. In at least three of the other bearing orchards, however, the addition of phosphorus has resulted in no important benefit."

5. "Neither phosphorus nor lime, when used alone, has shown any important influence on either yield or growth in apples. Lime may often have some indirect value, however, through its favorable influence on leguminous covers

[1] Quotations from State Coll. Bull., No. 153.

or intercrops, and possibly as an accompaniment of fertilizer applications. In the latter relation its chief effect has been on growth. Phosphorus is also generally valuable in connection with leguminous covers."

6. Potash, when applied alone, gave an increased yield in some experiments, a material increase in a few, but in some instances had an injurious effect. On account of the impossibility of defining just what the soil needs without experimentation, it is better to defer general use of potash until definite evidence of its value is secured. This can be done through a home experiment as outlined later in this chapter.

7. "The red color in apples can not be increased materially by any kind of fertilization, although potash and possibly phosphorus may sometimes assist very slightly. These colors are directly dependent on sunlight and maturity, with the latter occurring preferably on the tree. Hence such influences as normal development, late picking, light soils, open pruning, and mildly injurious or defoliating sprays are the chief practical means of increasing the reds in fruits, while opposite conditions tend to decrease them."

8. "The distinctly retarding influence of nitrogenous fertilizers and manure on color is simply due to delayed maturity, and is often an advantage in the case of the more northern varieties, such as Baldwin, Hubbardston and McIntosh, when grown in Pennsylvania. In such varieties, the color reduction is readily overcome by deferring the picking. With the York Imperial and similar, long-seasoned varieties, however, it may also be necessary to use nitrogen more sparingly and to utilize the other direct aids to color as much as possible."

9. "In these experiments, fertilization has usually had very little influence on the average size of the fruit. This is apparently because it acted primarily in increasing the total amount of fruit and foliage on the tree, both of which influences tended to decrease the average size of the fruit. Manure, however, usually secured a fair increase in size, probably chiefly because of its moisture-conserving effect. The importance of moisture is evident from the fact that water forms about 85 per cent of the average fruit. The chief means of increasing the size of the fruit, therefore, are proper thinning and moisture conservation."

10. "Evidence elsewhere indicates that the time of application is important, especially for nitrogen. It appears that nitrogen carried in nitrate of soda may often distinctly increase the crop of the current season if the application is made at the right time. This time seems to be about when the buds are beginning to open in the spring, or slightly later. When the applications are made much later than this, or when the slower-acting carriers of nitrogen are used, such as dried blood or manure, no important effects should be expected before the following year. The later applications, however, are often used in steadying the yields from year to year and hence should not be neglected." It should be borne in mind that the above conclusions are more applicable to the East.

There is a variance in opinion among experimenters as to how soon an appreciable influence is derived from application of nitrate of soda. Some feel that if applied well in advance of the bloom, it will materially increase the set of blossoms the same season. It is more commonly thought that since the morphology of the bud is determined in the preceding season, the application of nitrate can have

little or no effect on the set of blossoms of the current season.

It has been found that many failures with potash and phosphorus are due to a deficient nitrogen supply. It is quite a common belief that if fertility is low all the elements of plant-food are needed, when very often the soil is deficient only in one or two elements. Potash and phosphorus, if not actually required, may tend to check or balance any ill effects of nitrogen. Therefore, it is generally recommended by Stewart that for the average orchard, an application of 500 pounds to the acre of 6–8–5 fertilizer be employed. This means a fertilizer carrying 6 per cent of nitrogen, 8 per cent phosphorus and 5 per cent potash. If commercial fertilizer is not used and stable manure is available, it is recommended that about 8 tons of the latter be applied annually to an acre, especially when the trees indicate the immediate need of fertilizing. Commercial nitrogenous fertilizer, especially nitrate of soda, is quicker in action than manure, and the same is claimed for sulfate of ammonia. It is generally concluded that in case of young trees stable manure is more satisfactory, as it usually furnishes all deficient elements of plant-food needed for growth. A good system for mature trees, under middle western and eastern conditions, is to apply nitrate of soda, 4 to 8 pounds, acid phosphate, 6 to 8 pounds, and muriate of potash, 2 or 3 pounds to a tree. Of these fertilizers, nitrogen is the most important and likely to be most needed.

Nitrate experiments by Lewis.

The Oregon experiments by Lewis have brought out some additional conclusions with regard to the application

of nitrogen and at the same time have confirmed several of the results obtained elsewhere. While Stewart recommends 4 to 8 pounds of nitrate of soda to a tree, Lewis advises 3 to 4 pounds. This difference in opinion, however, may be accounted for by the variance in conditions. The Lewis recommendations refer to northwestern conditions where the trees are much smaller than those of the East, while Stewart's findings are more applicable to the older and larger trees of the East. The recommendations and results emphasized by Lewis as applying particularly to the northwestern conditions are as follows:

1. An application of 5 pounds of nitrate of soda quickly restored devitalized trees.

2. The benefits of nitrate application were quickly apparent, as shown in the dark green foliage.

3. Nitrates stimulated the wood growth.

4. Nitrate of soda produced much more attractive blossoms and a much better set, even in the current season when application was made a month in advance of the bloom. (Some experimenters disagree.)

5. A much larger percentage of the bloom set fruit on fertilized trees than in the case of trees which had not received this treatment.

6. There is a greater tendency for the fertilized tree to bloom more annually and evenly.

7. It was shown very conclusively that nitrate of soda is the cause of greatly increased yields.

8. Nitrate has a direct effect on the marketable quality of the fruit, causing the specimens or individual apples to become much larger than those on unfertilized trees. This is somewhat at variance with Stewart's conclusions

which were to the effect that the size of the fruit is little affected by fertilizer.

9. The degree of color on red varieties receiving nitrate was not as high on the whole as those which received none, but good commercial color was easily secured unless amounts of nitrate used were excessive.

10. It was found that up to a certain amount, the response to nitrate of soda was in direct proportion to the quantity of fertilizer used. However, 3 to 5 pounds to a tree under normal conditions was more satisfactory than larger amounts. Some applications in excess of 5 pounds to a tree, although increasing the total fruit produced, lowered the color to a point seriously detracting from the commercial quality.

11. It was found that the influence of nitrate was more marked in heavy crop years than in years of light production.

12. The benefits from the use of nitrate extended over a period including two seasons from the date of application.

13. The greatest benefit came from applying nitrate to devitalized trees which had received continuous clean tillage.

14. Best results were obtained when nitrate was applied about a month before the tree bloomed.

It was found at the Oregon station that Yellow Newtown trees which received early fertilizing averaged 7.9 boxes to a tree while late fertilized trees averaged much less. In the case of the Esopus (Spitzenburg), the early fertilized trees averaged 10.83 boxes to a tree while the late fertilized trees averaged much less. The results of

this experiment indicate that application must be made early if appreciable effects are to be obtained the current season. By comparing such experimental data as is available at the present time and from data secured from individual growers in various parts of the country, the authors recommend early application of nitrate of soda, preferably a month before blooming. This recommendation applies to both eastern and western conditions.

AMOUNT OF FERTILIZER TO A TREE

The amount of fertilizer to be applied must necessarily vary with the size, age and vigor of the tree. Although nitrogen is likely to be the most needed element, if orchard soils show general depletion, an application of acid phosphate 6 to 10 pounds to a tree and muriate of potash 2 to 3 pounds to a tree, as well as nitrate, is usually advisable. Under northwestern conditions, 5 pounds of nitrate of soda to a bearing tree is probably sufficient to restore fertility. Under eastern conditions where trees are older and fruiting surface is greater, larger amounts are advisable, 6 to 8 pounds of nitrate of soda to a tree being usually recommended. These amounts are for trees which show a distinct need of fertilization. Lesser amounts will suffice where need is not so evident. If trees are healthy, but are still making only small annual growth, if foliage tends to be pale green or yellow and also sparse in the late summer or fall, and if crops are only medium to light, it is highly probable that fertilization will be profitable and particularly the application of nitrate of soda. To determine the needs of the soil, some actual test should precede any wide general treatment. As a rule, young healthy orchards do not require fertilizing. Older orchards will

usually respond to moderate applications of nitrate of soda, even though they may have no clear indication of the need. In such cases, the amounts to be applied should be reduced.

NEEDS OF IRRIGATED REGIONS

The importance of nitrogen as the limiting element of plant-food is emphasized under western irrigated conditions where the nitrogen-content of the soil is soon exhausted unless replenished by the growing of legumes or by application of manure or commercial fertilizer. The system of clean culture with irrigation, practiced so extensively at one time in the Northwest, caused more or less rapid depletion of humus and nitrogen. The results of this harmful practice became very evident in the famous Hood River Valley of Oregon. In about 1915, the orchards of this well-known region were producing rather small annual crops; the foliage was beginning to take on a yellow appearance, particularly in the non-irrigated orchards where no leguminous shade-crops were grown. It became apparent that some change in orchard management was necessary to bring back the yields and vigor of the trees to normal. It was in these circumstances that the value of nitrate of soda was demonstrated. While the importance of nitrates as commercial fertilizers is recognized in the Pacific Northwest, and particularly in Oregon, the value of acid phosphate and potash commonly recommended in the East in conjunction with nitrates has not been established in the irrigated regions. In other words, eastern orchards more commonly require general fertilization, while northwestern plantings are not likely

to require anything but nitrogen. This need is being supplied in part by the quite general practice of growing leguminous shade-crops.

NITRATE OF SODA

Nitrate of soda as a fertilizer will be more and more widely used. At first the commercial apple-growers looked askance at this means of maintaining soil fertility, there being a theory that once given nitrate of soda treatment a tree would require continual stimulation. This theory has been disproved, however, and a single application of nitrate of soda may prove beneficial whether later applications are made or not. Continued moderate application at intervals of about two years may prove desirable, however.

Hood River, Oregon, has been mentioned as one region in which this form of fertilization has proved profitable. The value of nitrate of soda is also recognized in the Ozarks, southern Indiana, western Michigan, in Virginia and particularly in southern Ohio. Wherever the soil is naturally deficient in nitrogen or where the nitrogen has been exhausted through the planting of other crops, this deficiency can and should be quickly remedied.

METHODS OF APPLYING FERTILIZERS

It may not always pay to apply commercial fertilizers indiscriminately to all trees in an orchard. In other words, one may profitably single out trees which are in need of treatment and omit others. In the average orchard, there will be many trees which are growing vigorously and fruiting well. At the same time, there are likely to be

trees which are growing indifferently and not bearing well. These latter are in need of fertilization. It is, therefore, a good plan to go through the orchard and tag such trees in the summer so that they may be manured or fertilized the following spring according to their individual needs.

The common method of applying commercial fertilizer is simply to scatter it broadcast under the trees from two weeks to a month before bloom, care being taken not to get it too close to the trunk. Application should extend well out beyond the spread of the branches in order to conform more closely with the usual distribution of the feeding roots. Heaviest application should be made over the area covered by the outer two-thirds of the branches. Fertilizer may be left on the surface to be carried down by the rain or it may be harrowed or lightly plowed into the soil. Barnyard manure may be applied at almost any time, although applications late in the growing season are likely to over-stimulate wood growth. Winter dressings are most common.

With nitrate of soda good results have been secured by dividing the amounts to be applied into two parts, making the first application about a month in advance of the bloom and the second about a month after the fruit has set. Favorable responses have been obtained from second applications as late as July. The rate of the second application may vary, according to the size of the crop which the tree is carrying, heavier application being profitable in full crop years. The double application of nitrate of soda is credited with a tendency toward steadying and maintaining annual yield. In most regions this fertilizer is scattered broadcast in dry form, largely on the area cov-

ered by the outer two-thirds of the branches. In a few regions where spring rains are infrequent, liquid applications have proved advisable.

PRUNING WITH REFERENCE TO FERTILIZING

In connection with fertilizer studies, it has been found that efforts toward building up the soil and improving fruitfulness should be accompanied by regular and moderate pruning throughout the entire tree. Excessive heading back or heavy thinning of branches should be avoided unless the trees have entered such a decline as to necessitate the encouraging of heavy wood growth.

FERTILIZER TESTS

It is concluded from the foregoing discussion that soil fertility is of utmost importance and should be carefully maintained. Careful orchard management and the use of commercial fertilizer when necessary should forestall the depletion of plant-food. It has been emphasized that the critical factor in soil fertility of leading apple regions is available nitrogen supply. In regions in which yields are low and trees show pale foliage and lack of vigor, it is highly probable that the application of nitrogen fertilizer will be profitable. It is simple to conduct a test with a few trees and the results are quickly apparent. In many instances the increased yields will cover the added cost of the fertilizer many times over. It is anticipated that nitrogen fertilizer will become more and more popular among commercial apple-growers.

A good orchard test is suggested by Stewart, although most commercial growers hesitate to go to the trouble of making it. The importance of testing fertilizers is appar-

ent when one realizes the marked difference in results obtained in separate experimental orchards. It is wise to try fertilizing on a small scale before assuming any large financial risks.

"This test should be located in a typical section of the orchard and include not less than six average trees of the same variety and age in each plot. It is also best to have the trees in double rows whenever possible and the plots by a single row left unfertilized. All trees should be labeled and carefully measured at a fixed point on the trunk, and the applications and exact records of both yield and growth should be maintained for at least three years. Good indications of an orchard's needs may often be obtained in much less time, but at least this period should be allowed.

(Rates are stated for each mature tree in bearing.)

1. Check (unfertilized).
2. Nitrate of soda, 5 lbs.
3. Nitrate, 5 lbs.; acid phosphate (16 per cent $P_2\ O_5$), 8 lbs.
4. Nitrate of soda, 5 lbs.; potash (50 per cent. K_2O), 2 lbs.
5. Check.
6. Acid phosphate, 8 lbs.; potash, 2 lbs.
7. Nitrate, 5 lbs.; acid phosphate, 8 lbs.; potash 2 lbs.
8. Manure, 400 lbs.
9. Check.

"Other carriers, such as ammonium sulphate or dried blood, may be used for the nitrogen; and bone meal or possibly 'floats' may be used for the phosphorus. The present materials are likely to be best in the absence of cultivation, however, and they are also quicker in their action as a rule."

GENERAL SUMMARY AND SPECIFIC RECOMMENDATIONS

(1). Cost production studies emphasize the importance of high yields. Judicious fertilization is a direct method of increasing yields.

(2). Nitrogen is the limiting element of plant-food in most orchards. It can be supplied best in one of the following ways:

(a) Barnyard manure, 8 to 10 tons to the acre annually.

(b) Nitrate of soda, applied two to four weeks before bloom; 3 to 5 pounds to a mature tree under western conditions; 4 to 8 pounds to a tree under eastern and middle western conditions. Amount varies with age, size and vigor of tree.

(c) Growing of such leguminous shade- and cover-crops as alfalfa, clover or vetch.

(3). Nitrogen tends somewhat to increase the size of the fruit, particularly on weak trees. It increases the number of fruits more noticeably. It may reduce color by checking maturity.

(4). Phosphorus and potash applied in conjunction with nitrogen have given generally better results than nitrogen alone. This has not been definitely established under western and some eastern conditions.

(5). Potash may improve color to slight degree.

(6). The application of about 6 to 8 pounds of nitrate of soda; 7 to 9 pounds of acid phosphate and from 2 to 3 pounds of potash to a mature tree may be considered full treatment for soils generally depleted in fertility. Local tests should be made before extensive application of

commercial fertilizer is made, since conditions vary exceedingly in different orchards.

(7). Two to four weeks before bloom is the time recommended for applying nitrate of soda. Other fertilizers may be applied at the same time. Method of application is by broadcasting fertilizer principally on the area under the outer two-thirds of bearing surface of tree.

(8). Over-application of commercial fertilizers is to be avoided. Unfruitfulness is not always due to depleted soil fertility. Tests in fertilization should be conducted to determine needs.

(9). Barnyard manure is an excellent fertilizer for apple orchards, particularly for young trees when rapid wood growth is desired; also for old trees which need stimulation to produce normal annual growth.

(10). Leguminous cover-crops are very important in maintaining humus and nitrogen supply, and very often obviate the necessity of applying commercial fertilizer.

(11). Some old orchards, particularly in western New York, apparently do not respond to commercial fertilizers but this does not mean that commercial fertilizers are not valuable under most conditions.

CHAPTER X

DISEASES AND PESTS OF THE APPLE AND THEIR CONTROL

In recent years much attention has been given to the study of insects and diseases attacking the different fruits. It is impracticable here to describe all of the pests which are found on the apple and for fuller accounts the reader is referred to the "Manual of Fruit Insects" by Slingerland and Crosby and "Manual of Fruit Diseases" by Hesler and Whetzel.

IMPORTANT INSECT ENEMIES OF THE APPLE

The codlin-moth (*Carpocapsa pomonella*). (See Plate XI.)

This insect, of European origin, is widely disseminated, being present in practically all of the important apple regions of the world. In the United States it is recognized as the most serious insect enemy of the apple and is responsible yearly for a great loss of fruit. The codlin-moth, more commonly known as the "apple worm," feeds within the fruit, causing the so-called "wormy apple." In the early part of the season much of the wormy fruit falls to the ground, but the fruit attacked later is not so likely to drop. In regions in which this pest is abundant, many of the apples as they near maturity are frequently "stung." This refers to the small shallow excavations

through the skin made by the worms before they succumb to the poison.

The seriousness of this insect is somewhat variable from season to season and in different fruit-growing districts. In the eastern states the codlin-moth can be controlled by one to three thorough spray applications. In the Middle West and in the arid fruit-growing regions of the West, the insect is more difficult to control, often requiring six to seven sprays. It thrives especially under the warm dry climatic conditions of the West, whereas its development in the East is retarded by the occurrence of rains and periods of cool weather. The number of broods is influenced by weather conditions as indicated by the fact that there are four broods in the Pecos Valley of New Mexico while in Maine there is practically but one, the second brood being very small.

The codlin-moth passes the winter in the worm or larval stage, within a small silken cocoon which is normally spun beneath the loose bark of the trunk. By the time the apples are in bloom, many of the worms have changed to the pupal state, after which they further transform and issue as moths. The eggs are deposited on the leaves and sometimes on the fruit itself. The worms hatch usually in six to ten days, depending on the weather, and soon eat their way into the fruit if it is not properly protected by poison.

Before proper control measures can be applied, it is essential to know the life history of the codlin-moth. It is important to have information on the number of broods and the time when each brood is hatching in maximum numbers. It will, therefore, be readily appreciated that no one spraying schedule will be applicable in all fruit-

growing districts, but instead a spraying scheme that will meet local conditions should be adopted.

The following suggestion will be helpful in controlling the codlin-moth: (1) Arsenate of lead powder should be used, 2 pounds of the paste to 50 gallons of water or fungicide. (2) The importance of thorough spraying for the calyx treatment can not be too strongly emphasized. This application may be started when 85 to 90 per cent of the blossoms have dropped and must be completed before the calyces have closed. (See Plate XI.) The calyx cups should be literally drenched to insure filling each one with the poison. The spray should be applied with nozzles throwing a coarse spray under a pressure of 200 to 225 pounds. The upper parts of the trees should be sprayed from a tower. (3) In regions in which the codlin-moth is serious, every effort should be made to reduce the first brood as much as possible. If necessary, three cover sprays should be made for this brood: (a) Just before the worms begin to hatch (three to four weeks after the calyx spray); (b) as the worms are hatching in large numbers (ten to twelve days after a); (c) as the late hatching first-brood worms are appearing (ten to twelve days after b).

If the first brood is not practically eradicated, no subsequent spraying will eliminate wormy and "stung" fruit. In order to catch the first-brood worms that have escaped being poisoned, it would be well either to band the trees or to employ the codlin-moth trap. A large proportion of the first-brood worms transform in a few weeks to moths, the females of which are capable of laying as many as 300 second-brood eggs. From this the fruit-grower will realize the importance of killing as many first-brood worms as possible. In spite of the above precautions, however,

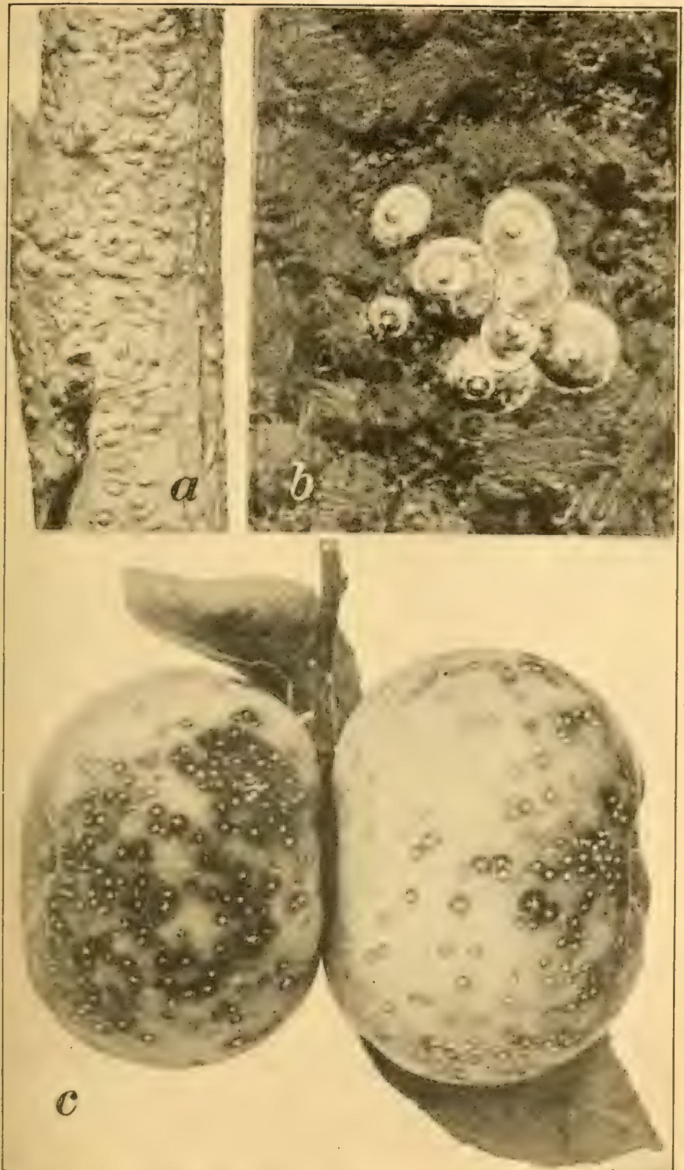


PLATE XII.— San José scale: (a) natural size; (b) enlarged; (c) appearance of this pest in the apple.

some worms will escape both the poison and the mechanical means of capture and it will, therefore, be necessary to spray for the later broods.

The following spray schedules are suggested:

Schedule I (One spray).	(1) Calyx spray.
Schedule II (Two sprays).	(1) Calyx spray.
	(2) 3 to 4 weeks after 1
Schedule III (Three sprays).	(1) Calyx spray.
	(2) 3 to 4 weeks after 1
	(3) 8 to 10 weeks after 1
Schedule IV (Five sprays).	(1) Calyx spray.
	(2) 3 to 4 weeks after 1
	(3) 5 to 6 weeks after 1
	(4) 8 to 10 weeks after 1
	(5) 12 to 14 weeks after 1
Schedule V (Six sprays).	(1) Calyx spray.
	(2) 3 to 4 weeks after 1
	(3) 5 to 6 weeks after 1
	(4) 6 to 7 weeks after 1
	(5) 8 to 10 weeks after 1
	(6) 12 to 14 weeks after 1

Maine to *Connecticut:* Frequently schedule I will suffice, but if not schedules II or III should be employed.

New York to *Virginia:* In some fruit districts within these states schedule I will give satisfactory commercial control of the codlin-moth. Where it is more abundant, schedules II or III will be necessary.

Ohio to *Michigan:* Usually schedule III will give satisfactory control.

Illinois to Arkansas: There is considerable variation in the relative infestation of the codlin-moth in these states. In some fruit districts schedule III will suffice, while in others schedules IV or V should be employed.

Kansas, Colorado, New Mexico, Utah: The severity of the codlin-moth in these states varies to a considerable degree and the best spray schedule for each fruit-growing district will depend on the local conditions. In many of these districts, schedule V should be employed, supplemented by banding or the codlin-moth trap.

Idaho, Washington, Oregon, California: In many of the fruit-growing valleys in these states the codlin-moth is a pest of first rank, requiring for best control schedule V together with banding and the use of the codlin-moth trap.

San José scale (*Aspidiotus perniciosus*). (See Plate XII.)

The San José scale is one of the most common and injurious apple pests. It is widely distributed throughout practically every commercial apple region. The mature scale is gray in color, circular, and about the size of a pinhead. A nipple-like protuberance in the center distinguishes it from other scales of similar appearance. The scale is merely an excretion for protection; the louse is bright lemon in color and when crushed emits a perceptible juice.

Annual spraying with lime-sulfur (30°–33° Baume) 1 to 8 is recognized as proper treatment. It is desirable to delay the application until early spring, at a time when

there will be the greatest hold-over effect against young scale. This occurs just as buds are swelling. For badly crusted infestation of scale, crude petroleum oils are effective. As a rule, San José scale is now well controlled by spraying. Control measures are directed particularly to protect the fruit from infestation.

Oyster-shell scale (*Lepidosaphes ulmi*). (See Plate XIII.)

The oyster-shell is another common scale insect which is not as serious, however, as the San José. The shape is distinctive and resembles very closely a long narrow oyster-shell. It is about 1/8 inch long, brown in color, although sometimes grayish. Oyster-shell scale is not so widely distributed as San José scale nor is it usually a menace in regions where the latter is serious. It seems to prefer a higher altitude.

The dormant lime-sulfur spray is not as effective in the control of oyster-shell as of San José scale, yet in most instances it seems to control both insects. Two or three weeks after the blooming period, the old oyster-shell scales begin to loosen and the young lice start to crawl about. Application of distillate oils, kerosene emulsion, or lime-sulfur (1 to 35) is usually effective at this time. Nicotine sprays, 1 to 200, are also effective although somewhat more expensive.

Apple aphids.

Four well-known species of plant-lice affect the apple. Two of these, the oat aphis and the green aphis are greenish in color and feed chiefly on the foliage, causing it to curl. The third species is commonly called the rosy apple

aphis (*Aphis sorbi*) because of its pinkish to purplish color. This louse is a more serious pest than the others since it not only attacks the foliage, but also causes severe damage to the young apples. (See Plate XV.) These injured fruits, known sometimes as "aphis apples," are frequently much dwarfed and distorted in shape and have no commercial value. The fourth species is the woolly aphis (*Schizoneura lanigera*), easily recognized by its whitish, cotton-like appearance, particularly when in colonies. This species feeds chiefly on the twigs, axils of the leaves, the trunk, especially where the outer bark has been injured, and the roots. (See Plate XIV.)

The life history of plant-lice is somewhat complicated and worthy of brief mention. The oat aphis and rosy aphis migrate to other host plants in the summer, but return in the fall to deposit their eggs on the apple twigs. The green apple aphis breeds on the apple during the entire season as does also woolly apple aphis, although the latter has an alternate host plant in the elm.

The control of plant-lice is difficult, but by careful and timely spraying satisfactory results can be obtained. The oat, green and rosy aphids hatch in the spring about the time the green tips of the foliage appear. The lice congregate upon these tips and soon commence to feed.

It is in this short period that the fruit-grower has the best chances of effecting control by thorough spraying with a contact insecticide, as nicotine sulfate (40 per cent) at the rate of 1 to 1066 (3/8 pint to 50 gallons of water to which has been added 2 to 3 pounds of soap). If it is desired to spray for the San José scale, it may be done at this time, thus giving the tree the so-called "delayed dormant" treatment for the San José scale and apple aphids.

The best spray combination for this treatment is standard lime-sulfur solution 1 to 8 plus 40 per cent nicotine sulfate 1 to 1066 (3/8 pint to 50 gallons). The soap should not be used when lime-sulfur is employed as they are not compatible.

The above-ground colonies of the woolly apple aphis may best be treated in the summer by a drenching spray of 10 per cent kerosene emulsion. The nicotine spray does not penetrate the woolly covering of these lice as well as the oil spray, otherwise the nicotine solution might be used. As yet, no satisfactory method of combating the woolly aphis on the roots has been found, but growing trees on resistant stock, as the Northern Spy, is desirable in regions in which this pest is troublesome. In spraying all plant-lice it is important to remember that these are sucking insects.

Plum curculio (*Conotrachelus nenuphar*).

The mature insect is a snout-beetle which punctures the young fruit in the early stages and causes misshapen fruit. Codlin-moth sprays serve to check plum curculio although control may not be entirely effective. Infestation is favored when orchards are in sod or grown up to weeds. Where this pest is prevalent, an arsenical should be added to the pink spray application. (See Fig. 3.)

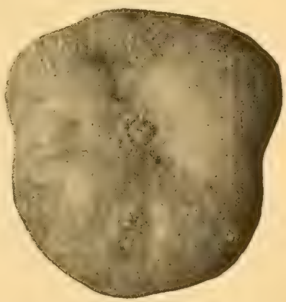


Fig. 3.— Apple showing the egg and feeding punctures of the plum curculio as well as the distorted shape of the fruit attacked.

Apple red bugs.

Red bugs (*Heterocordylus malinus* and *Lygidea mendax*) have come into prominence chiefly in New York state. They do not seem to have spread to the Middle or Far West, although they are more prevalent in Connecticut and on up through New England into Nova Scotia. These insects puncture the apples early in the season, causing them to drop before maturity or to be misshapen and undersized. Nicotine sulfate, 1 to 800, combined with the pink spray for the scab has given best results. A repetition of the nicotine application with the calyx spray may be necessary.

Apple-tree tent-caterpillar (*Malacosoma americana*).

The ordinary spray program including lead arsenate usually controls the tent-caterpillar and rarely is it a serious pest. The nests may be destroyed with torches and the egg-masses may be detached and removed while the trees are leafless. (See Plate XV.)

Round-headed apple-tree borer (*Saperda candida*).

This insect may be particularly injurious to young apple trees and even matured ones. The larvæ attack the trees near the base and feed for the first season under the bark, later tunneling deeper into the wood during the second and third years. In infested orchards, trees should be wormed annually with a knife and wire. Painting the trunks with pure white lead and oil from a few inches below the ground to a foot above may serve as a repellent and reduce egg deposition by the adult beetle. Egg deposition begins in

May and June and is continued until August or September. (See Plate XIII.)

Cutworms.

Cutworms are sometimes injurious, particularly in young orchards planted near timber. The worms work chiefly at night, feeding on the buds and tender foliage. During the day they may be found in the soil at a depth of about an inch. A poison bran mash deposited near the trunk of the trees acts as a control measure.

Bud-moth (Tmetocera ocellana).

In well-sprayed orchards, the bud-moth is not as a rule injurious. The caterpillars of this insect pass the winter in little cases near the buds and when growth starts in the spring they feed within the small leaves, folding them together with silken threads. Late broods attack the apples by burrowing into the flesh. Arsenate of lead, 2 pounds paste to 50, in the scab spray is usually effective against this insect, although an earlier arsenical spray may be necessary.

The fruit-tree leaf-roller (Archips argyrospila).

This insect is especially injurious in New York, Missouri and Colorado, often stripping fruit-trees and ruining many of the young fruits. The most efficient method of control is to destroy the eggs early in the spring, using miscible oil, 1 part to 19 parts of water; or a 10 per cent kerosene emulsion may be used. Arsenical sprays are necessary to kill the insects, 6 pounds arsenate of lead in 100 gallons of water, making the first application as soon

as the buds begin to burst, and the second when the blossom buds in the cluster begin to separate. (See Plates XI, XIII.)

IMPORTANT APPLE DISEASES

Apple-scab (*Venturia pomi*).

The scab is probably the most widely distributed and most destructive apple disease. It thrives in cool moist climates and is particularly injurious in western New York, New England and Michigan. Occasionally it causes heavy losses in cool rainy seasons in Illinois and other middle western regions. The Hood River and Rogue River valleys, Oregon, are the only western apple regions which have suffered materially from scab. The fact that severe scab attacks are intermittent and depend largely on the season is likely to cause growers to become careless and an unexpected scab year very often proves disastrous. (See Plate XVI.)

The disease is evidenced by brown or grayish spots on fruit and leaves. Badly attacked apples may be dwarfed and very often crack open. The disease is spread by means of spores and lives over the winter on fallen leaves.

Lime-sulfur 1 to 35, in combination with lead or nicotine if desired, is effective against scab. Applications should be made (1) in the pink just before the blossoms open; (2) in the calyx; and (3) two to three weeks later. The first two sprays are the most important, since the fungus becomes active with the starting of growth in the spring. Late applications of lime-sulfur are sometimes necessary in bad seasons. While a three-spray program usually suffices, it does not always serve in seasons when

spore development is particularly favorable. Only those growers who make two and even three late sprays are able to produce reasonably clean fruit under such conditions.

Apple-blotch (Phyllosticta solitaria).

This is essentially a middle western apple disease, being particularly injurious in southern Illinois and Indiana, in the Ozarks, southern Kansas and occasionally in the Missouri River region about St. Joseph. Most susceptible varieties in these states are Missouri Pippin, Northwest Greening and Ben Davis.

The disease attacks the fruit, leaves and twigs, wintering over in twig cankers. Injury to the fruit is most serious and appears in the form of hard roughened brown spots, irregular in shape and sometimes sunken. Three-cornered cracks in the fruit are characteristic of the disease.

Bordeaux mixture (3-4-50) is considered most effective against apple-blotch, and lime-sulfur (1-35) in a lesser degree. The latter with the calyx spray and three Bordeaux sprays at intervals of about three weeks, beginning two to three weeks after the petals fall, is recommended as an effective program against severe apple-blotch. The first Bordeaux spray is most important.

Sooty-blotch and fly-speck (Leptothyrium pomi).

This disease does not penetrate the skin, but detracts greatly from the appearance of the fruit. It appears in two manifestations, the former in large sooty blotches and the latter as minute black spots on the skin of the apple. These diseases are usually controlled by the regular summer fungicides. (See Plate XVI.)

Cedar-rust (*Gymnosporangium juniperi-virginianæ*).

In some regions, particularly in the Virginias, the cedar-rust has become a serious menace. It appears on the apple in bright yellow spots as large as ½ to ⅜ inch in diameter. In the yellow area are small black specks or pustules. The foliage is similarly affected and late in the season blisters or cushions are found on the underside of the leaves. The cutting down of all cedar trees within a radius of at least a mile is the principal corrective measure.

Bitter-rot (*Glomerella rufomaculans*).

Bitter-rot is very serious in certain commercial apple regions in the South, particularly in the Piedmont district of Virginia and in parts of the Ozarks. The fungus works in the tissue of the apple, causing first small light brown spots just beneath the skin of the apples. These spots may increase rapidly in size, attaining a diameter of an inch or more, and are usually sunken. Occasionally the apple assumes a peppered appearance and with yellow varieties as the Newtown, the margins of the spots may become purple or reddish in color. (See Plate XVI.)

The disease is spread by spores, transmitted by rain drops, insects or birds. It may appear any time between the middle of June and the middle of September, being favored by warm moist seasons. The Yellow Newtown or Albemarle Pippin is very susceptible and Ben Davis, Gano, Grimes and Jonathan more or less so.

Bordeaux mixture (4-4-50) applied from June 15 to July 1, July 15 to 20 and August 1 to 5 is generally considered the best control program. The disease winters

over on mummied fruit and in cankers in the bark. These sources of infection should be removed when the disease is bad.

Blister-canker (*Nummularia discreta*).

This canker, sometimes spoken of as the Illinois blister-canker, is the most destructive apple disease in the Middle West. It is particularly prevalent in the Illinois, Ozark and Missouri River regions where it has caused heavy loss in trees. The fungus gains entrance strictly through wounds in the roots or branches. The initial cankers produced by the disease vary in size from 2 to 18 inches in length and from ½ to 6 inches in width. Their appearance very often resembles that of cankers produced by winter-injury, sun-scald, blight or collar-rot, except that blister-canker affects not only the bark, but also the wood. The bark becomes shrunken and assumes a darker color and the cankers increase in size as long as the branch remains alive. The disease is spread by means of spores and infected wood.

Unfortunately, the most important varieties of the Middle West are the most susceptible to this disease, namely Ben Davis and Gano. The Delicious, though not widely grown in these regions, is also susceptible. Oldenburg, Wealthy, Winesap and Jonathan are more resistant. Whole trees often appear to die in a single season although as a matter of fact the infection has probably been present for several seasons, but has been invisible from the outside. The disease makes rapid progress in drought years.

Treatment must be preventive rather than curative. Once infected, a tree can be saved only by the removal of the infected wood. Fortunately, vigorous well-cared-for

trees are very much less susceptible to the disease than slow-growing neglected individuals. As stated above, infection always enters through wounds and for this reason all pruning and other wounds should be disinfected and covered. White lead and oil or liquid asphaltum are recommended as suitable coverings for wounds. A mixture of two-thirds coal-tar and one-third creosote serves not only as a covering, but also as a disinfectant. Cheap grades of these materials are adequate.

Heavy pruning encourages rather than checks the disease and for this reason should be avoided in regions where blister-canker is serious. Preventive measures may be summed up as follows: (1) Avoid heavy pruning; (2) disinfect and paint all wounds; (3) remove all infections from diseased trees; (4) select resistant varieties; (5) keep trees vigorous.

Collar-rot.

The seriousness of collar-rot has become apparent in many commercial apple orchards and the cause of this injury has been the subject of considerable study. Certain varieties such as Grimes, the trunk wood of which does not harden fully for the winter and which for that reason is more subject to injuries from alternate freezing and thawing, seem more susceptible to collar-rot than others. Collar-rot on Grimes is also sometimes attributed to fire-blight. The connection of certain fungi have been associated with collar-rot injury, but at the present time there is no authentic publication which describes the isolation of any particular fungus responsible for the injury for which specified treatment is recommended. Trees in

1

2

3

PLATE XIII.— Insect enemies of the apple. (1) The fruit-tree leaf-roller egg mass from which the young caterpillars have hatched; (2) The rounded-headed apple-tree borer in its tunnel at the base of a young apple tree; (3) The oyster-shell scale: (left) scale turned over to show eggs; (middle) mature scale; (right) young scale.

low wet ground or near irrigation ditches are sometimes susceptible to collar-rot.

In working about trees, care should be taken not to scrape the bark or cause wounds at or about the collar. Such wounds may permit the entrance of either saprophytic or parasitic fungi.

Observations have been made of the successful removal of infected or rotted tissues after which bridge-grafting or the planting and grafting in of young trees about the base of the trees has resulted in the saving of many collar-rotted trees. The practice, while recommended for isolated cases, is hardly advisable on a large scale. The process is expensive and not always successful.

Fire-blight (*Bacillus amylovorus*).

Fire-blight or pear-blight is a bacterial disease which affects both apples and pears and, while less serious on apples, it is responsible for heavy loss in apple regions. The disease is caused by microscopic bacteria working just underneath the bark in growing tissues of the trees.

The presence of blight is generally evidenced during the growing season by a wilting of the leaves and branches above infected parts. The disease winters in hold-over cankers which at the beginning of spring growth exude drops of infected gum. Insects are attracted to the sweetened gum and very often carry the germs with them from flower to flower during the period of pollination. Bees are well-known carriers of the disease and aphids very often spread infection through feeding punctures. The first sign of blight in the spring is usually apparent when the infected blossom-spurs begin to wither and die, result-

ing in what is known as twig-blight. Confusion very often results from the use of such terms as twig-blight, blossom-blight and trunk-blight. In reality they are synonymous, being merely different names to designate the part of the tree infected.

Fire-blight is more or less prevalent in all apple regions, but has been particularly serious in the Pacific Northwest on account of the presence there of susceptible varieties. The Esopus (Spitzenburg) is more subject to blight than any other leading commercial variety. Spitzenburg orchards in the Yakima Valley have suffered severely in bad blight years. On the other hand, the heavy Spitzenburg plantings in the Hood River Valley, Oregon, have been very little injured. It is difficult to say just how far local climatic and soil conditions affect the spread of this disease, but unquestionably they are important factors.

Preventive measures consist in checking wood growth. Blight works on tender succulent wood. Aphids unquestionably are active in spreading this disease and their control is important.

After infection, the removal of the diseased portion is the only treatment. In the care of infected branches, the cut should be made about ten inches below the last visible sign of the blight. Wounds should be disinfected with cyanide of mercury, 1 to 500; tools should be disinfected with corrosive sublimate, 1 to 1,000.

Apple rosette.

The apple rosette is a physiological disease more or less prevalent in certain regions, particularly in the Northwest. The disease is evidenced by a shortening of the terminal growth. Buds are crowded together by a failure

of the branch to elongate. The result is a whorl of leaves at the tip and an absence of leaves along the side of the limb, which lends to the branch somewhat the appearance of a feather-duster. The exact cause of apple rosette is unknown. Abnormal soil condition or insufficient nourishment may be responsible. In the Northwest the sowing of alfalfa in affected orchards has seemed to exert a beneficial effect. Good orchard practice, designed to promote normal growth of the trees, seems the principal corrective measure.

Baldwin-spot.

This form of fruit-pitting is probably a physiological disease due to abnormal plant growth. More and more emphasis is being placed on good orchard management as a correction to such physiological affections. The maintenance of soil fertility and correct soil management are of particular importance. In the Pacific Northwest, regular irrigation with neither too much nor too little water is essential in controlling such diseases.

An internal browning has been more or less prevalent in the Newtowns grown at Watsonville, California. Experiments in controlling this latter disease have been conducted for a number of years, but the disease is still puzzling to horticulturists.

ANIMAL PESTS OF THE APPLE

Meadow mice.

The field or meadow mouse has become a menace in many orchard regions, particularly in the South where the sod-mulch provides harbor. The mice attack the trees by

gnawing the bark from the trunk at or near the surface of the ground. Most of this injury is accomplished in the winter under cover of snow, although it may occur any time during the year.

The runways of meadow mice are found entirely on the surface of the ground under weeds, leaves, brush and similar litter. Ordinarily, orchard sanitation, including the removal of trash and litter from about trees and fence rows, will suffice to control this pest, although poisoning may be necessary for bad infestation.

Pine mice.

The pine mouse is not dissimilar to the field mouse except that it is smaller and reddish-brown instead of the characteristic grayish-brown color of the field mouse. While the field mouse is more widely distributed throughout the country, the pine mouse is more injurious and more greatly feared in regions where it is prevalent. The Virginias have suffered severe depredations in recent years. In one Virginia county alone, it is estimated that the loss from pine mice would amount to $300,000 annually. The pine mouse works almost entirely below the surface of the ground, feeding on the roots of the apple trees, girdling the trunk at or below the surface of the ground and in many instances tunneling along the roots and eating the bark for a distance of several feet from the trunk of the tree. While the field mouse usually works under cover of snow and is particularly bad in years when a heavy coating of snow remains on the ground for a considerable period during the winter, the pine mouse works beneath the surface of the ground and in all seasons of the year. Its activity in most cases is not apparent until the tree

attacked begins to wilt and is beyond recovery. For bad infestation by pine mice, the orchardist must introduce and continue careful and thorough poisoning.

Control of mice by poisoning.

It is a good practice for the orchardist to carry a can of poison about with him and as he discovers holes or runways, to deposit a few of the grains of poisoned wheat in the openings, covering the latter with trash or leaves in order to make the trap more effective. Poisoning must be done systematically. Badly infested orchards should be first disced and cultivated in the spring. In poisoning it is well to send two or three men down a single tree row. By following a zigzag course and carefully looking for runways or holes, effective and systematic poisoning may be done. One man should easily cover from one to two acres in this manner in a day. A careful orchardist in an infested area should go over his orchard several times a year.

Trees once girdled or partially so will soon die if exposed to the sun or drying action of the wind. For this reason the practice of poisoning should be accompanied by a search for injured trees. If the wounds can be covered by heaping fresh soil about the trunk, the tree may be saved and later a permanent recovery may be effected by bridge-grafting.

A good poison formula for control of these mice is as follows:

½ ounce strychnine
1¾ pints water
4 pounds sugar
½ peck wheat

Boil strychnine, sugar and water together for ten or fifteen minutes, then add the wheat and boil a few minutes longer. Remove the mixture from the fire and stir vigorously until the wheat has become thoroughly coated. If, on cooling, the mixture does not sugar, it may be necessary to boil a few minutes longer. It is highly important that the mixture be stirred vigorously in order that the poison may be distributed and the grains of wheat properly coated. The wheat will not ferment and may be kept indefinitely. It is claimed that chickens are not affected.

SPRAYING

Spraying as known to-day has come into general practice only within the last fifteen or twenty years. The development of the power sprayer has made practicable the spraying of large commercial tracts and at the present time no other single operation defines so clearly the distinction between commercial and non-commercial fruit-growing. It is now generally accepted that spraying is necessary to the production of strictly commercial apples.

It is unquestionably true that insect pests and diseases are becoming more numerous and growers in new regions may not reasonably expect their orchards to be immune from the attacks of insects and diseases which thrive elsewhere under similar conditions. With the present means of communication and with increased number of host plants, isolation becomes less and less a factor. Fortunately, the increased energy of these attacks on apple trees has been accompanied almost simultaneously with the development of more effective spray control methods. No other orchard operation in the growing of commercial apples requires such thorough study as does spraying, and

pays more on the investment, and yet no other practice is more likely to be slighted. Growers are now coming to look on spraying as a form of insurance and well thought out spray programs are being adopted in every region.

While the last twenty years mark the period within which spraying has come into general use in commercial apple-growing, the history and development of spraying plants dates back much further. There are authentic records of trees having been "syringed" in Europe as early as 1763. The history of spraying indicates that this practice was probably not unknown much earlier than this date. In 1872 paris green was first recommended as an efficient spray material to be used against the canker-worm in southern Illinois. Eight years later probably the first experiment in the control of the codlin-moth with the use of an arsenical poison was conducted in Michigan by Cook who reported having successfully used London purple in spraying crab-apple trees. In 1892 and 1893 arsenate of lead was introduced largely as an outgrowth of the gipsy moth control work. While greater emphasis was laid on insecticides in the early history of spraying, the development of suitable spray materials for fungous diseases was almost simultaneous.

It is exceedingly difficult to describe exact methods of spraying. Thoroughness is all important. Leaking valves, leaking spray hose and faulty equipment should be avoided. Spray applications should be made promptly and at critical times, as delays are costly. For this reason the equipment should be thoroughly gone over well in advance of the season.

It is impossible to fix a definite spray program which can be followed absolutely. Continued rain or other inclem-

encies may intervene. The seasonal development of pests and diseases varies greatly. The spray problem requires individual study with careful regard for general principles in control methods.

Cost of spraying.

The results of cost-production studies as applied to spraying lack stability since labor rates vary greatly in different regions and change from year to year even within a given district. The cost of spray material suffers similar changes. However, the amount of labor as expressed in man and horse hours does not fluctuate greatly and affords a reliable basis for comparison. The writers conducted detailed cost studies in hundreds of orchards in various regions of the United States and a number of important points regarding the amount of labor involved and material used were brought out. In the cost studies, a three-man and two-horse crew operating a power spray outfit was taken as a basis. Dusting and the spray-gun were not used.

It was found that such a crew sprayed on the average of three to five acres of bearing trees in a ten-hour day. It was noticeable that the northwestern growers sprayed out more material in a day than those in other districts, the average of Yakima and Wenatchee being 1,750 gallons a day. The same size crew operating in western New York averaged only 1,100 gallons a day. This disparagement in favor of the efficiency of the western spray crew may be explained partly by the fact that the presence of water in irrigating ditches greatly facilitates the reloading of spray tanks and in this way increases the efficiency of the spray crew.

TABLE XI

SHOWING RATE AND COST OF APPLYING SPRAY MATERIALS IN SIX OF THE LEADING APPLE REGIONS

	Wenatchee	Yakima	Idaho	Hood River	Western Colo.	New York
Acres a day ...	3.4	4.24	3.57	5.47	3.8	4.6
Gallons a day..	1766	1743	1253	1205	1904	1150
Gallons an acre.	515	411	379	223	501	250
Gallons a tree..	6.3	5.3	6.3	3.1	6.8	7.0
Average number sprays	3.4	4.98	4.09	5.65	3.7	3.5
Cost of spraying	$37.00	$42.00	$40.00	$30.00	$36.00	$25.00
Cost of labor ..	20.00	26.00	23.00	18.00	22.00	14.00
Cost of materials	17.00	16.00	17.00	12.00	14.00	11.00

The accompanying table shows the amount of spray materials used and the rate of application in different regions. These and other data are taken to show the approximate cost of spraying one acre of bearing orchards for an entire season in each of six important apple regions. In studying the amount used for a tree for each application, the size and variety of the tree should be considered. For example, the grower in Hood River, Oregon, applies on an average of only 3 gallons to a tree as compared with an average application of over 6 gallons to a tree elsewhere. The Hood River Newtown with its low head is not to be compared in size with a forty-year-old New York Baldwin tree and therefore does not require the amount of spray. As a matter of fact, if the New York grower would spray his Baldwin trees as thoroughly as the Wenatchee grower sprays his Winesap, he would probably use at least twice

as much material instead of about the same amount of 7 gallons a tree.

The dormant lime-sulfur application is included in the averages of Table XI, but as a rule requires somewhat more labor and of course involves more expensive spray material. Considering the best sprayed orchards, it becomes apparent that the spraying operations represent an annual outlay of at least $40 a bearing acre if depreciation of spray outfit is to be included.

Spray equipment.

There is considerable variation in the type of spraying outfits. For the small grower, hand outfits such as bucket or barrel sprayers may be sufficient, but for the commercial grower the power spray is essential. At present the power sprayers operated by gasoline engines are in almost exclusive use, although traction and compressed air outfits have been employed with some success.

Generally speaking, a good spray outfit is a most profitable investment. For the operator of a moderate sized orchard, the common outfit is a three- or four-horse-power gasoline sprayer with a two- or three-cylinder pump, capable of delivering 6 to 9 gallons of spray material a minute under a pressure of 200 to 250 pounds. The 200-gallon tank is most popular. It pays to buy a good sprayer. Heavy repair bills and lack of efficiency very often make the cheap sprayer most expensive in the end.

For the large commercial grower, the high power gasoline outfit with four-cylinder pumps and four-cylinder automobile type engines from 10 to 12 horse-power are not uncommon. These large outfits are capable of delivering as high as 15 gallons of spray material a minute

under pressure of 200 to 300 pounds. The grower can profitably study the different makes of power sprayers before making a selection. Before buying he should insist on seeing a thorough orchard demonstration of the model in question.

No other one new device since the power sprayer was invented has met with such general interest as the spray-gun, for which the fruit industry is indebted to John Hull of Gasport, New York. The idea has been developed by a number of manufacturers. The gun consists of a short metal rod attached to the end of a spray hose. The original spray-gun was constructed so as to deliver a maximum of 15 gallons of spray a minute. Under heavy pressure, a great cloud of spray could be sent out, reaching a height of 46 feet. Experiments have not actually determined the relative value of the spray-gun as compared with the old rod and nozzle, but growers have not waited for published reports. The spray-gun was introduced to offset the effect of dusting and is now being used by hundreds of growers. Some criticism is voiced against the gun for the calyx spray in controlling codlin-worms. When used from a tower, this criticism is mitigated to a greater or less extent. Speed is the chief recommendation for the spray-gun. The operator usually stands on a tower and with a single gun sprays two rows from a steadily moving spray outfit.

For apple orchards in full bearing, the spray tower is a necessary accessory if thorough work is to be performed. Planting schemes should provide sufficient space between mature trees to permit the use of a tower in reaching the topmost branches. Various tower designs are in use. Strong iron rods supporting a small square platform with

railing are suitable material. Wooden towers are more inexpensive. When trees are close together, a tower supporting a single wooden bar or " horse " which the towerman may straddle is a more suitable form.

Nearly every grower has a favorite type of nozzle and there are many different designs. In the main there are two broad classifications, the Vermorel or eddy-chamber nozzle and the Bordeaux type. With the former, the spray is introduced into an eddy chamber and leaves the artifice in a cone shape mist. With the Bordeaux nozzle, the spray leaves the nozzle with a direct force, but is deflected into a fan shape by striking an obtrusive bar or lip. The Bordeaux nozzle provides a more direct driving spray and is preferred by many growers for the calyx spray when it is desirable to drive the poison down into the calyx cups. For cover sprays, the eddy-chamber nozzle is more popular. In the first place it does not wear out so quickly. It also uses spray material more economically than the Bordeaux nozzle and does not catch on the branches. While the Bordeaux nozzle will deliver 2½ gallons to 3 gallons a minute under 200-pound pressure, the eddy-chamber delivers from 1½ to 2 gallons. The Bordeaux nozzle causing a driving, fan shaped spray is heartily indorsed by some for the calyx application. For thorough work it may be more effective, although for an all-round nozzle the " Friend " type or disc nozzle is desirable.

Hired sprayers.

In some regions, particularly in the northwestern irrigated sections, it is often customary to hire a spraying outfit by the day or hour. Thus one grower may do his own spraying and that of several neighbors. The small

grower resorts to this practice when he feels that his acreage is insufficient to warrant the purchase of a power outfit.

In considering custom spraying, two decided disadvantages weigh heavily against this practice. In the first place, the value of spraying and its relative cost may only be measured by its efficiency. No matter how cheap the cost, careless spraying is expensive. To be efficient, a spray must be applied at the critical period. If one has to wait for a custom sprayer, very often the value of the spraying is partly lost. The second reason is that while figuring only labor and material costs the hired sprayer may be cheaper, it is considerably less efficient. On sixty-nine fruit-farms studied in the Yakima Valley, thirty-nine growers owned their own sprayers and thirty hired their spraying done. In every instance the custom sprayer applied on the average of one-third less material to a tree. It is quite likely that in every instance this was false economy. The hired outfit will not perform the careful work which a grower himself will do.

It is not to be concluded from this discussion that the small orchardist is invariably justified in owning a power sprayer. It has been found that the average depreciation and upkeep of a power spray outfit amounts to practically 25 per cent a year. Thus a $500 sprayer investment means an annual outlay of $125 in addition to labor and material. On a five-acre orchard, this cost alone would be $25 an acre. It is doubtful whether the orchardist with less than ten acres is justified in owning a power sprayer.

Regional spraying notes.

The northeastern states.— The commercial apple-growers in Michigan, New York and New England fear

the apple-scab more than any other disease. In New York the infestation of the apple red bug is serious in some localities and in New England the gipsy and the brown-tail moths have caused considerable losses. The apple-scab is quite prevalent throughout New England as is also the apple-maggot. Scab is particularly feared by the growers of McIntosh apples in this region.

The middle Atlantic states.— The Piedmont grower of Virginia suffers heaviest loss in seasons favorable to the development of bitter-rot. The Yellow Newtown (Albemarle Pippin) is particularly susceptible to this disease which may occur late in the season and very seriously injure the crop when nearly mature. Serious epidemics of apple-scab are uncommon, although this disease is more or less prevalent throughout the Piedmont district. In the Shenandoah-Cumberland region of Virginia, West Virginia, Maryland and Pennsylvania, the pine mouse has been a most destructive orchard pest in recent years. Cedar-rust has also been very destructive and has precipitated a campaign for the eradication of cedar trees in the vicinity of orchard plantings. Root-rot is proving to be one of the most destructive of all orchard diseases in these four states and as yet there is no recognized means of control.

The Middle West.— Throughout the Middle West the apple-blotch is the most serious disease affecting the fruit and the blister-canker, sometimes known as the Illinois blister-canker, is the most injurious to the trees, particularly those of the Ben Davis variety. Apple-scab is prevalent in favorable years, while bitter-rot is often serious in the Ozarks, southern Illinois and southern Indiana.

Western boxed-apple region.— The most serious pest in

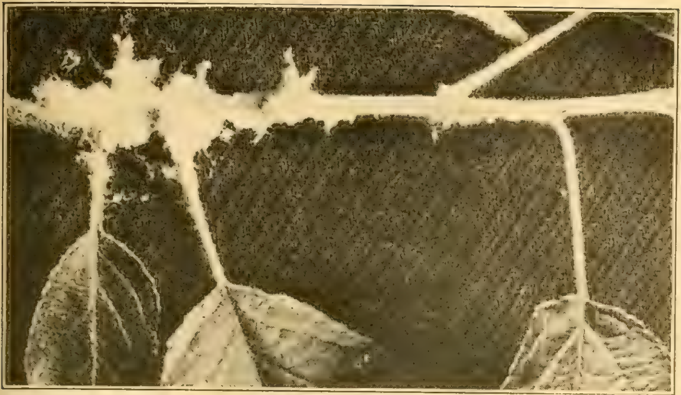


PLATE XIV.— The Woolly Aphis. *Upper*, Ground colonies of the woolly aphis. *Lower*, Apple roots distorted and injured by the woolly aphis.

the western orchard section is unquestionably the codlin-moth. The dry arid climate in nearly all the irrigated sections seems particularly favorable to its development. The long hot seasons increase the number of broods and seem to stimulate the activities of this pest. Furthermore, the close grading of the fruit emphasizes the loss from worm injury. Eastern growers are justified in feeling that they have worked out a satisfactory spray program against codlin-moth and are inclined to believe that the western grower is deficient in his spraying methods for controlling this insect. Yet in many instances growers on the western slope of Colorado and the Yakima Valley, Washington, have found it difficult to avoid excessive codlin-moth loss even after spraying much more thoroughly and frequently than is necessary under eastern conditions. Fire-blight epidemics have been more or less serious in the West and have been particularly injurious in the Yakima Valley, Washington and the Rogue River Valley, Oregon. In the Rogue River and Hood River valleys, Oregon, the apple-scab has been serious in years when the climatic conditions were favorable to its development. However, elsewhere in the West fungous troubles are in the main inconspicuous.

California.— The Watsonville apple-grower in the Pajaro Valley must devote considerable attention to the control of the tussock moth. The leaf-roller is also rather prevalent and the powdery-mildew causes more or less injury.

DUSTING

Dusting, as a substitute for the liquid spray method in controlling insects and disease, has been brought to the recent attention of fruit-growers by the extensive experi-

ments conducted in western New York in 1911–1913 by Blodgett of Cornell. These experiments have been continued elsewhere in different parts of the United States by various state and federal investigators. The practice of dusting has been adopted with greater or less success by many commercial growers in different regions. Its status has not been definitely determined, but certain conclusions may be drawn from results thus far obtained.

In the first place, dusting has certain inherent advantages over the use of liquid spray: (1) More trees may be covered in a given time and with less labor than with the liquid spray; (2) dusting is more convenient in rough hilly orchards; (3) considerable time is saved in loading the machine with material; (4) the elimination of water reduces very materially the weight of the spray material to be hauled through the orchard; (5) the equipment cost is much less than for liquid spraying machine.

In comparing the cost of common dust materials, such as arsenate of lead and superfine sulfur, with that of similar materials used in liquid sprays, it appears that the dusting method is more expensive, particularly if much dust is lost in the application in windy or unfavorable weather. In considering labor cost, dusting may be cheaper than spraying with liquids, and it is on this point that advocates for dusting lay particular stress. The spray-gun more recently developed has reduced this advantage of the dusting method over the liquid spray. But certainly the grower may cover his trees at the critical period in less time and with less labor cost by dusting than with liquid spray applied with rods.

A two-man crew operating a dusting machine can cover from three to four times as many trees as a three-man

crew operating a liquid spray outfit with the old rods. It is estimated that fifteen-year old trees require on the average of about 1 to 1½ pounds of dust for a single application, while trees twenty to twenty-five years old require approximately 2 pounds of dust. The time and amount of material vary greatly with the conditions and methods of application. These data will convey in a general way the relative speed of the two systems.

The following formulæ are quite generally used:

Formula I. Combination dust for chewing insects and fungous diseases:

Arsenate of lead, powder ... 10 to 15 per cent.
Sulfur, superfine .... 90 to 85 per cent.

Formula 2. For insect infestations and light fungous attacks:

Arsenate of lead .... 10 per cent.
Sulfur .... 50 per cent.
Hydrated lime or gypsum .... 40 per cent.

Formula 3.

Arsenate of lead, powder .. 10 to 15 per cent.
Hydrated lime or gypsum .. 90 to 85 per cent.

It is rather difficult to dogmatize on the efficiency of dusting. Some growers, after a more or less thorough trial, are convinced of its economy and efficiency. Other growers have discarded their dusting machines. In western New York dusting has not become general. Improved dusting mixtures and better methods of application may result in greater popularity for this method, for it has certain time-saving advantages. However, at the present

time it has not been altogether successful in controlling bad scab infection, excessive codlin-moth, or apple-blotch, the three most serious apple diseases and pests. It seems possible that dusting may prove better adapted to regions where the codlin-moth is not particularly serious or scab infection critical. For hilly orchards or orchards where water supply is remote, or where liquid spraying is exceedingly difficult, the use of dusting may be recommended as a substitute.

The power duster is usually operated by a two- or three-horse-power gasoline engine. The dust mixture is fed into a rapidly revolving fan by means of a hopper and a strong current of air forces the dust out through a discharge pipe. A single operator directs the cloud of dust by shifting the discharge pipe.

INSECTICIDES

In studying insect control, the first consideration should be given to the methods by which insects secure their food. Generally speaking, there are two classes of insects: (1) biting and chewing insects such as codlin-moth and tent-caterpillar; (2) sucking insects such as aphids and scale. When insects feed on such exposed parts as the buds or leaves, arsenicals or other stomach poisons are necessary. In the case of chewing insects which feed beneath the bark, such as borers, other control methods must be employed. Sucking insects are best checked by the use of contact sprays such as lime-sulfur, nicotine, and kerosene emulsion.

Following is a general classification of common insecticides:

(1) Insecticides for biting insects — arsenate of lead, paris green, calcium arsenate and arsenite of zinc.

(2) Insecticides for sucking insects — lime-sulfur, nicotine solution, miscible oils, so-called dry-lime-sulfur compounds.

For biting insects.

Arsenate of lead is the most widely used poison for chewing and biting insects. It is particularly effective against the codlin-moth. Both powdered and paste forms are in common use, the powder having come into recent popularity on account of convenience in handling. Of the two kinds of lead arsenate, one is known as ortho, triplumbic or neutral lead arsenate and the other as standard or diplumbic lead arsenate. The diplumbic or acid lead is now being employed almost to the exclusion of the ortho or triplumbic form, although the latter is sometimes recommended for more tender foliage or in regions where foliage is likely to be burned by arsenicals. Best brands of paste lead contain from 15 to 17 per cent of arsenic oxide, while powdered forms usually contain approximately double that amount, the 50 per cent water-content having been removed. Two pounds paste or 1 pound arsenate of lead to 50 gallons of water are standard strengths. Before the lead is added to the spray-tank, it should be made into a thin paste by the addition of water or preferably reduced to a solution in 3 or 4 gallons of water. Particular attention should be given to mixing the powdered forms so that the suspension will be complete. Strengths of less than 2 pounds of paste lead arsenate to 50 gallons of water have not as a rule given satisfaction. At present a number of experiments are being conducted in the Northwest in

which arsenate of lead is being used 3 and even 4 pounds paste to 50 gallons of water. Where the codlin-moth is becoming a more serious menace, it is thought that by increasing the dosage, quicker killing effects may be secured and the loss from later stings may be reduced.

Paris green is an arsenical poison which has been largely superseded by arsenate of lead, the latter having proved more adhesive, more compatible with other spray materials and less likely to cause burning. Paris green is not widely used in any commercial apple region.

Calcium arsenate is being tried out in many parts of the United States and, although more or less in an experimental state of development, has given some promise, particularly when used on apples under eastern conditions where codlin-moth infestation is not serious. The powdered forms contain 42 to 45 per cent of arsenic-oxide and the paste forms 17 to 20 per cent. When employed alone in the Northwest, some burning resulted. The addition of paste lime at the rate of 2 or 3 pounds of stone lime to 50 gallons of water is considered a wise precaution against burning. Combination of lime-sulfur, summer strength, with calcium arsenate has thus far proved satisfactory. Calcium arsenate has not been widely employed in any commercial apple region, although it is being tested by many growers at present. Commercial forms lack the smoothness and fineness which characterizes the well-known brands of arsenate. It is not improbable that the physical properties of commercial calcium arsenate can be greatly improved. Experiments have thus far given some promise. Complete results of thorough trial and demonstration will be awaited with interest. Although it has not yet demonstrated the quick-killing properties of lead,

calcium arsenate is cheaper pound for pound than lead and this may cause its ultimate introduction in the East where codlin-moth infestation is not the menace which it is in most irrigated regions. Calcium arsenate is still in the experimental stage.

Arsenite of zinc is a quick-acting poison which in powdered form contains about 40 per cent arsenic-oxide. It is used in tussock moth control in the Pajaro Valley or Watsonville district, California, but on account of its tendency to burn it has not been employed elsewhere.

For sucking insects, contact sprays.

Liquid lime-sulfur has become the standard dormant or winter spray for apples. It is a combination insecticide and fungicide chiefly valuable for its effectiveness against San José scale and certain other insects as well as against fungous diseases. It is to be preferred to any of the present forms of so-called dry lime-sulfur. For full winter strength, 1 to 8 is generally accepted as the proper rate of dilution. This rate applies to the concentrated commercial lime-sulfur testing 33° Baume. Weaker solutions should be diluted accordingly. The table of dilution on the next page will serve as guide.

For summer sprays, particularly for apple-scab, a weak solution of lime-sulfur is widely employed alone or in combination with nicotine and arsenate of lead. The strength at which summer applications of lime-sulfur cause burning varies with the season and the climatic conditions. Lime-sulfur has been used 1 to 10 in summer without injurious effects to the fruit or foliage. Again a dilution of 1 to 30 may cause foliage burning. It is generally accepted that 1 to 35 for the pink spray and later summer application

Table XII

Dilution Table for Concentrated Lime-Sulfur Solutions

Degrees Baume.	Specific Gravity.	Number gallons concentrated lime-sulfur to make 50 gallons spray solution.		
		Summer or foliage strength.	Winter or dormant strength.	
			San José scale.	Blister mite.
36	1.330	1¼	5½	4¾
35	1.318	1¼	5¾	5
34	1.306	1½	6	5
33	1.295	1½	6¼	5¼
32	1.283	1½	6½	5½
31	1.272	1½	6¾	5¾
30	1.261	1¾	7	6
29	1.250	1¾	7¼	6¼
28	1.239	1¾	7½	6½
27	1.229	2	8	6¾
26	1.218	2	8½	7¼
25	1.208	2	8¾	7½
24	1.198	2¼	9¼	8
23	1.188	2¼	9¾	8¼
22	1.179	2¼	10¼	8¾
21	1.169	2½	11	9¼
20	1.160	2½	11½	9¾

is a safe and effective dilution. Excessively hot days should be avoided in summer spraying with lime-sulfur. In the Middle West, Bordeaux mixture is very often preferred to lime-sulfur for the late summer sprays on account of its great effectiveness against blotch and bitter-rot. Some feel also that Bordeaux is less likely to cause burning.

Home-made lime-sulfur solution.— It has been demonstrated that the preparation at home of a lime-sulfur solution is practicable and very often economical. When a grower has less than four or five acres of orchard, it is probably advisable for him to buy the commercial lime-sulfur, since it is usually superior to the home-made; furthermore,

considerable difficulties attend the manufacture of lime-sulfur in small quantities. If the grower is operating a large orchard, or if several smaller growers can coöperate as is done in many instances, it is very often advisable for them to manufacture their own solution. The materials for making are: lime, use only fresh lump lime, free from foreign substances and containing at least 90 per cent calcium oxide and not over 5 per cent magnesium oxide; sulfur, either flowers of sulfur or commercial sulfur finely ground. Various appliances may be used for cooking lime-sulfur concentrates. A large iron kettle raised from the ground on loose stones, or kettles imbedded in masonry are suggested. When considerable amount of spray material is needed, a more elaborate plant will be practicable. Cooking with steam is the most satisfactory method and with a larger plant the installation of a boiler is advisable. A twelve-horse boiler will furnish sufficient steam for a cooker of 300 gallons capacity. Iron cooking vessels are usually preferable to wooden on account of danger of leak in the latter. The hydrometer is necessary for testing the density of the final solution. Table XII should be followed in making dilutions.

Preparation of home-made lime-sulfur solution.—

Formula

Fresh stone lime	50 pounds
Commercial ground sulfur	100 pounds
Water	50 gallons

Place the desired quantity of lime in the cooker or slaking-box, then add water (preferably hot, since hot water slakes the lime more quickly). Care should be

taken to use enough water to prevent too violent slaking or burning, although too much water is objectionable, since this will drown the lime. Mix the sulfur to a thin paste and add the lime, then the desired quantity of water. After the full amount of water has been added, the cooking-vat should be marked or a notched stick used to show the original amount of water. Keep adding hot water from time to time to replace that which has evaporated. The solution should not be allowed to boil down stronger than one-half gallon to each pound of sulfur, nor should there ever be much of an excess of water. The solution should be boiled for at least forty-five minutes but not longer than one hour. It is important that boiling should proceed vigorously and that the mixture should be stirred constantly. After the lime-sulfur solution has been made, it should be strained in order that the undissolved particles may be removed. Straining should be through an iron wire (never copper) 30 to 50 mesh to the inch. The solution should be allowed to cool before being tested with a hydrometer. If the solution is left exposed, a film of oil should be poured over the surface to exclude the air. It is highly important that all home-made lime-sulfur be tested with the hydrometer, otherwise the grower is merely guessing as to the strength of the spray. The sediment obtained in the manufacture of home-made lime-sulfur will be useful in painting the trunks of the trees.

Nicotine solution is recognized as a standard contact insecticide for summer spraying. It is particularly effective against aphids and may be used without injury to the foliage. A solution of nicotine sulfate containing 40 per cent nicotine such as Black Leaf 40 is the common commercial form. Proper dilution is given at 1 to 800 and

1 to 1,000. Soap should be added at the rate of 2 or 3 pounds to 50 gallons to increase the spreading and adhesive qualities of the spray. Nicotine may be used in combination with lead arsenate, lime-sulfur or both.

Miscible oils.—"Miscible" or "soluble" oils have come into considerable use as dormant sprays, particularly in the West where they have been found a satisfactory treatment for badly encrusted San José scale. The miscible oils have a tendency to spread after they have been applied and for that reason are particularly effective against scale insects. Home-made emulsions are used to some extent in California where the crude oils can be purchased cheaply. The question of injury resulting from continued oil spraying is disputed. It is advisable to make dormant oil spray in the late winter rather than in the fall. If oil sprays can be applied in the spring just previous to the swelling of the buds, preferably on sunny days, the danger of injuring the trees will be minimized. When hard water is being used for spraying, it is desirable to add 1 to 2 pounds of soda to each spray tank.

So-called dry lime-sulfur.— The active and killing ingredients of lime-sulfur determine the value of these sprays. The following table gives the relative cost of this liquid versus dry lime-sulfur compounds measured in terms of active sulfur. The comparison in this table is in favor of the liquid lime-sulfur. In lime-sulfur (dry), the active sulfur costs $18.90 for 100 pounds; in soda-sulfur $14.03 for 100 pounds, and liquid lime-sulfur only $8.03 for 100 pounds. The inference is clear that lime-sulfur solution is a much more economical form than the so-called dry lime-sulfur or soda-sulfur.

Table XIII

Dry Sulfur Preparation vs. Lime-Sulfur Solution

Insecticide and Fungicide Laboratory, Agricultural Experiment Station, University of California. (Berkeley), Nov. 1918.

Material.	Total active sulfur. (Approx.)	Cost of 100 lbs. active sulfur.	Amount equivalent to 1 gallon lime-sulfur solution.
Lime-sulfur solution (33 B.) Average retail price $11.26 per barrel.	26%	$8.03	1 gallon weighs 10.78 lbs.
Soda-sulfur .... Average retail price $8.00 per cwt.	57%	$14.03	4.9 "
Lime-sulfur (dry) .... Average retail price $10.40 per cwt.	55%	$18.90	5.0 "

Spreaders for the different insecticides.

The use of spreaders in securing a more uniform coating of spray is attracting considerable interest among experimenters and fruit-growers. Three so-called spreaders are more or less well known:

(1) Glue — 1 to 2 ounces to 50 gallons.

(2) Flour paste — 2 pounds flour reduced to paste, to 50 gallons of water.

(3) Soap — 2 pounds liquid soap to 50 gallons of water. Other soaps such as fish-oil, rosin or common laundry soap may be used at the same rate.

The use of soap with nicotine solutions is generally accepted as highly beneficial. Soap should not be used with lime-sulfur, however, but is compatible with arsenate

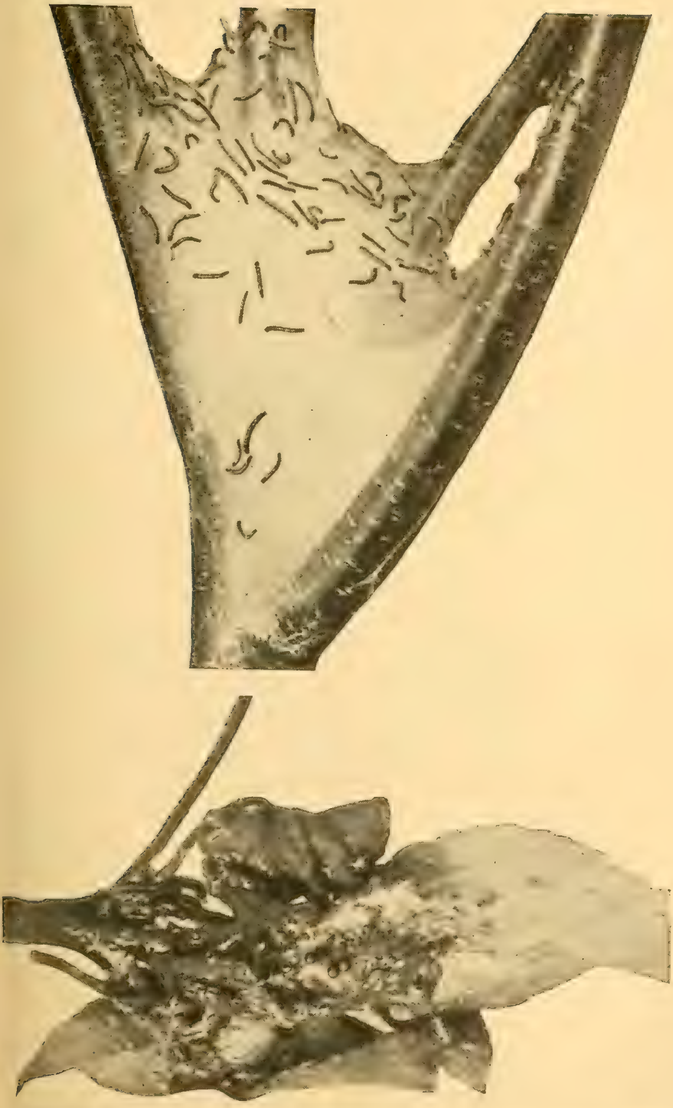


PLATE XV.— *Upper*, The tent caterpillar, nest and young caterpillars on wild cherry; frequently found in the apple. *Lower*, Rosy apple aphis and its effect on the foliage and fruit of the apple.

of lead and is highly recommended in combination with Bordeaux. The other spreaders named, glue and flour paste, are being used with arsenicals, but their status has not yet been definitely determined. It is thought that they may increase the spreading tendencies and effect a more uniform coating of these arsenic stomach poisons.

FUNGICIDES

Lime-sulfur has been treated on the preceding pages, as it is both an insecticide and fungicide.

Bordeaux mixture.— The standard formula for Bordeaux mixture is as follows:

Copper sulfate (bluestone)	4 pounds
Fresh stone lime	4 pounds
Water	50 gallons

Dissolve the bluestone and slake the lime separately with water. Bluestone may be conveniently dissolved by placing it in a burlap sack and suspending the sack in the upper part of a barrel or other receptacle filled with water. Stock solutions of this material may be made by dissolving 1 pound bluestone in 1 gallon of water and diluting to the required strength when ready for use. It is not advisable to make up in advance large amounts of this solution that cannot be used within a period of a few days. Nothing but wooden or earthen containers should be employed since copper sulfate (bluestone) reacts when brought in contact with metal ware of any kind. In slaking the lime, cover with just enough water to start slaking, then add water to prevent too rapid action and heating. Work the lime into a paste and dilute at the rate of 1 pound of lime

to 1 gallon of water for stock solution. When ready for use, 4 gallons of stock solution will represent 4 pounds of stone lime, sufficient for 50 gallons of Bordeaux mixture spray. When the mixture of lime and bluestone is to be made, it is a wise precaution to pour the two solutions simultaneously into the third receptacle in order that they will mix freely while going into the spray-tank or third receptacle. A strainer should be used when filling the spray-tank. Bordeaux mixture is the standard fungicide for bitter-rot and for blotch in the Middle West, and is used double strength in the fall for anthracnose.

Finely divided sulfur.— There are a number of finely divided sulfur compounds on the market known as atomic sulfur, "milled" sulfur and by similar trade names. Greater adhesion and greater spreading qualities are claimed for these compounds. They are used against the powdery-mildew in some of the orchard regions of the Pacific Coast.

CHAPTER XI

FRUIT SETTING AND POLLINATION

One of the most important phases of the orchard problem is pollination. Without this, fruit does not set and crops are impossible. Broadly speaking, there are two phases of the problem: (1) The primary effect of pollination, that is the fertilization of the pistils of the flower so that the bloom is capable of setting fruit; and (2) the secondary effect of cross-pollination about which much has been written, but about which there is still little definite information. In a study of the secondary effect of pollination such questions arise as what effect Baldwin pollen will have on the McIntosh apple or how the cross-pollination among certain varieties will affect the form, size, flavor or color of the fruit.

Many varieties are known to be self-sterile. This term is applied to varieties which are unable to set fruit without the aid of pollen from another variety. Here attention is called to the fact that pollen from a different tree of the same variety does not constitute cross-pollination. An indication of self-sterility is the continued dropping of young fruit from isolated trees or from trees in solid blocks of the same variety. Self-sterility is not a constant character with any variety. The same variety may be self-sterile in one region and nearly self-fertile in another. Emphasis is placed on the fact that local conditions greatly

influence self-sterility or self-fertility. Poorly nourished trees are more likely to be self-sterile than well nourished ones.

Imperfect pollination is more often due to other causes than the absence of suitable varieties for cross-pollination. Furthermore, it is not always necessary to have a heavy set of bloom to secure a heavy yield of fruit. It is well known that under normal conditions if 4 to 7 per cent of the blossoms set fruit in a good bloom year, a large crop of fruit is insured. If 10 per cent of the blossoms set fruit when the bloom is heavy, it is an indication of a very large crop. These facts do not minimize the importance of pollination, however, and it is highly important that every care should be taken to insure proper fertilization of the flowers. While the benefits of cross-fertilization are recognized as important in all plant-breeding work, the experimental data on the secondary effect of pollination are so contradictory as not to offer a field for definite discussion. The results of experiments to determine the effect of cross-pollination on color, form and flavor of the fruit have been largely negative. For that reason, this discussion will be largely confined to the primary effect of pollination.

CAUSES FOR THE FAILURE TO SET FRUIT

Failure of blossoms to set fruit properly is not by any means due in all cases to imperfect pollination. Many factors other than this affect the set of fruit and are more often the cause of light crops. Among the factors causing a light set of fruit are:

1. Fruit-spurs and trees may be weak on account of a lack of proper nourishment. When trees are starved for proper plant-food or when it is not made available by good

soil management, the fruit-spurs become weak and fail to set fruit-buds which have sufficient vitality to develop into fruit. This often accounts for the crop failure of old trees making little annual growth. In such cases, lack of proper nourishment is more often the cause of unfruitfulness than lack of cross-pollination.

2. Insects and diseases prevalent at blooming time may cause a poor set of fruit. Some of the bloom is often destroyed outright by various diseases, particularly apple-scab, anthracnose, or blight. Many blossoms may be ruined in their early development by the attacks of insects.

3. Extreme vegetative vigor of the tree on account of an excess of certain elements of plant-food may detract from fruitfulness. Often when a tree is growing too vigorously, it runs largely to wood growth and sets very few blossoms and even these are shed as soon as the blooming period is past. Excessive amounts of nitrate or manure when applied to orchards already making good growth often over-stimulate wood growth to the point at which the trees are almost barren. Furthermore, in such cases the fruit-buds go into the winter in an immature condition with less chance of escaping winter-injury. Most experimenters agree that wood growth can not keep up vigorously during the entire season without sacrificing a healthy set of fruit-buds.

4. Drought injury to trees may prevent the development of fruit-buds. It has been noted that when excessively long droughts occur, trees produce very little bloom the following season. The weakening influence of the drought prevents the formation of fruit-buds with sufficient vitality to form fruit. In such cases the tree requires all its energy to repair vegetative growth, and even though it may

bloom profusely the blossoms are so weak that they fail to set fruit.

5. Winter-injury to fruit-buds may occur. The apple ordinarily does not suffer greatly from winter-killing of fruit-buds. In the case of most varieties, the fruit-buds are no more sensitive to winter-killing than the tree itself. However, the vitality of the buds may unquestionably be affected by the character of the winter, particularly if the relative humidity is low. Dry atmosphere and soil are more often the cause of injury to fruit-buds than extreme cold.

6. The buds or bloom may be injured by late spring frosts. Often buds are injured by frost before bloom and if not killed outright are so weakened as to be unable to set fruit. Fortunately, when freezes occur before bloom, there are usually some buds which are not so far advanced as others and which for this reason escape injury. Severe killing frosts are those which occur when the trees are in full bloom or just as the bloom is being shed. Frost at this time may so impair the fruiting organs as to cause dropping of the fruit after it has once set.

7. Some varieties have an inherent inability to set fruit, although grown under favorable conditions and blooming profusely. These varieties are more frequently home orchard sorts and seldom trouble the commercial orchardist.

8. The last and one of the most important factors which affect the proper set of fruit is pollination. Proper pollination is usually dependent on one or some combination of six different factors: (a) In the case of self-sterile or partially self-sterile varieties, proper pollination can not take place unless other suitable varieties are present for pollinizers. (b) An absence of insects or other agents

may prevent pollination. Bees are almost essential. Other insects may be useful, but none is as active in carrying pollen from flower to flower. The importance of delaying the calyx application of lead arsenate until most of the petals have fallen is now emphasized by most horticulturists as a precaution against poisoning bees. Much has been said about the importance of wind as a pollinizing agent, useful in carrying the pollen from blossom to blossom and from tree to tree and much effort has been expended in determining its effectiveness. Most authorities agree that fully 99 per cent of all fertilized blossoms owe pollination to bees or other insects and less than 1 per cent to the wind. As a direct agency, therefore, wind has very little effect as far as carrying pollen is concerned. It may, however, prevent bees from working on the windy side of the tree and thereby cause a lighter set of fruit on the exposed than on the sheltered side. (c) Rain or cold weather is a factor affecting pollination. Cold, wet or damp weather during the blooming period often checks the activity of bees and sometimes prevents the germination and causes decomposition, or devitalization, of the pollen-grains. Unfavorable weather at blooming is a very important factor in reducing the set of fruit, particularly through the central western states, and often in the East. (d) Very hot and dry weather may also prevent proper pollination, particularly if accompanied by wind. Excessive heat may injure the stamens so seriously that they can not properly mature their pollen or it may cause dehiscence of the anthers before the pollen matures. (e) Excessively windy weather. Strong winds, particularly if accompanied by rain are very injurious to the blossoms. The rain is likely to wash away the pollen-grains and strong

winds prevent the activity of bees. In very hot weather high winds may so entirely dry up the fluid secreted by the stigma as to make germination of the pollen-grains impossible. (f) Spraying in full bloom. Injury is caused and pollination is sometimes prevented if trees are sprayed in full bloom before pollination has taken place.

The above discussion outlines some of the influences affecting the set of fruit. It now becomes important to consider mixed varieties with relation to cross-pollination. It is generally recognized that too much emphasis was formerly placed on the advisability of mixing varieties in order to aid in pollination. As a result, many orchards were set with mixed varieties when two or three well selected kinds would have provided for cross-pollination and would have been a much more desirable arrangement from a commercial standpoint. The orchardist too often proceeded on the theory that if a few different varieties were advisable as pollinizers, many were the more desirable. As a matter of fact, one variety which is a good pollinizer may serve exactly as well as a score. The much discussed secondary effects of pollination should not be allowed too greatly to influence the planting of pollinizers. The direct effects of crossing certain varieties have not been established. Variations in the characteristics of different apples are now more generally attributed to bud variation than to cross-pollination. It is generally conceded that flavor, quality or color of apples is not directly affected by the cross-pollinating variety.

This should in no way be construed as an argument against cross-pollination, for in the case of the self-sterile or partially self-sterile varieties it is absolutely essential. Cross-pollination may effect the size of fruit and may

increase the set. Darwin states: "Nature abhors self-fertilization."

ESSENTIALS FOR A GOOD POLLINIZER

The following points should be considered in selecting varieties for pollination: (1) Not more than one row in six is necessary to insure certainty of proper pollination under normal weather conditions and in the presence of pollinizing agents. However, attention is called to the fact that varieties to be handled economically should occur in plantings of at least two or three rows. (2) Varieties should bloom at the same time. This is clearly necessary, otherwise the pollen of one variety would be entirely gone before the other bloomed, making cross-pollination impossible. (3) Varieties must have an affinity for each other; that is to say, the pollen of one must be acceptable to the pistils of the other. It is well in this connection to mention the fact that pears will not serve to pollinate apples or vice-versa. (4) Varieties must be good pollen-producers. If varieties which produce little pollen are planted with those producing abundant pollen, the former but not the latter will be benefited. It is important here to mention that Winesap is a very shy pollen-producer and should not be planted for the purpose of pollinating other varieties. (5) Varieties should come into bearing at about the same age. Such kinds as the Northern Spy would not immediately serve as pollinizers for the Wagener or Twenty Ounce, since the former is an extremely late bearer. (6) The varieties should be commercial. While this is not at all necessary so far as cross-pollination is concerned, it is highly important from a commercial standpoint. It is clearly inadvisable to plant non-commercial

varieties as pollinizers when so many good commercial sorts are readily available.

It is important in any discussion of pollination to name some of the varieties which are known as uncertain or self-sterile as well as some of those known as self-fertile. Cross-pollination with some other variety is usually advisable, since in most cases it increases the set of fruit.

Uncertain or Self-sterile Varieties.	Dependable or Self-fertile Varieties.
Arkansas	Ben Davis
Tompkins King	Baldwin
Grimes	Oldenburg
Jonathan	Rhode Island Greening
Gravenstein	Yellow Transparent
Northern Spy	Yellow Newtown
Ortley	
Red Limbertwig	
Rome Beauty	
Esopus	
Twenty Ounce	
Winesap	

The following varieties are grouped according to their desirability for securing best results in pollination. Each column contains those which are well pollinated by any one or more of the varieties in the same column. Certain limitations should be placed on this table, since in certain localities some compatible kinds bloom too early to pollinate later-blooming varieties. However, the pollen of each has an affinity for the pistil of the varieties in the same column.

I	II
Arkansas Black	Wealthy
Baldwin	Rome Beauty
Ben Davis	Yellow Transparent
Gano	Yellow Bellflower
Grimes	White Winter Pearmain
Jonathan	Winesap
McIntosh	Willow Twig
Yellow Newtown	Wagener
Northern Spy	Esopus
Ortley	
Gravenstein	
Oldenburg	
Red Astrachan	

Many other varieties might be named, but these lists contain a sufficient number to satisfy the commercial grower. If a region is particularly adapted to a combination of any two or three commercial sorts, they may be interplanted with great success without detracting from the very important practice of limiting the number to a few commercial varieties. At the same time such combinations will insure abundant opportunity for proper cross-pollination.

CHAPTER XII

PRUNING AND THINNING

Pruning will always remain a field for independent and individual study. No other orchard practice has aroused in the minds of fruit-growers and horticulturists greater variance in opinion. While investigators and observers are in accord on many of the principles of pruning, their application must always remain, to some extent, an individual problem. An apple-grower would do well to study pruning in the most productive orchards of his community and observe the system that has been practiced on the best and most productive trees.

It is the purpose to give a brief description of the several pruning practices in use in the more important fruit-producing sections and to state briefly the advantages and disadvantages of such practices.

Before planting, the ends of all broken or injured roots should be removed. This is done not with the idea of shortening the roots, but with the view of leaving smooth rather than broken and ragged root ends. Occasionally a few roots may be removed so as to avoid crowding and secure better distribution of the root system.

Since a large proportion of the root system is removed when the tree is taken from the nursery, it is necessary to remove a portion of the top to restore a proper balance between the root system and top. Again, the removal of

a portion of the top determines the height of head and encourages the formation of a stocky and vigorous framework.

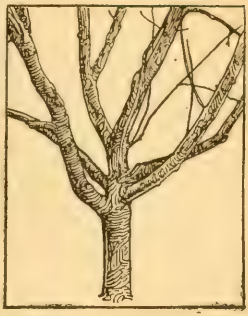


Fig. 4.—Showing framework of a young Jonathan tree. The trunk is too short and the branches too nearly horizontal.

The height of heading will vary with the type of training to be followed and the locality. Lower heading is practiced with the open center type of tree than with the leader or modified types, as is pointed out elsewhere in this chapter. In those sections in which sun-scald is prevalent, it is necessary to head lower than where this trouble is not a factor. The height of heading apples at planting time may thus vary from 20 to 36 inches. (See Fig. 4.)

TYPES OF TRAINING APPLE TREES

All pruning practices are applied with the idea of developing the type of tree suited to the local conditions or conforming to the ideas of the individual. The pruning given trees during the first few years may be referred to as training. There are several methods of training apple trees, those in common use in commercial regions throughout the United States being: The "natural form"; the "central leader" type; the "open center," or "vase-shaped" tree; the "double headed" type; and the "modified leader," or "modified open center" tree.

Natural form.

This system of training has been followed largely in the old orchards of New York, New England and some of the middle western states, and by growers generally who had no definite type in mind. Very little pruning is required as compared with other methods of training. The top ordinarily consists of a cluster of branches springing from one point and forming a round head. The pruner merely removes crowding and crossing branches and limits the number of main branches. In the more humid climates, later pruning is confined to the removal of crossing and crowding branches and to the shortening of wayward branches for the purpose of maintaining tree balance. In the drier climates of the Middle West, all the branches are usually headed back for the first few years in order to encourage stockiness.

Advantages.

1. Most simple type of training and work may be done by unskilled men.

Disadvantages.

1. Too many main branches are frequently left, resulting in crowding and overlapping main branches.
2. Splitting at the crotches is not uncommon.
3. Frequently main branches are not stocky enough to support loads of fruit in natural positions, the result being overlapping branches and much poorly colored fruit.
4. Uneven distribution of fruiting wood is not uncommon when trees become mature.
5. Trees in the orchard lack uniformity.
6. Trees of this type often require heroic treatment later on.

PLATE XVI.— Diseases of the apple. 1, Bitter-rot on Pippin showing spots
l red specks. 2, Sooty-fungus and fly-speck. 3, Apples affected with the
b fungus. 4, Leaf affected with apple-scab.

Central leader system.

FIG. 5.— A well pruned young Jonathan tree trained to the central leader form.

By this method one central leader is allowed to develop year after year until its increasing height is naturally checked as the tree begins fruiting. Such lateral branches are allowed to remain as will not crowd and will give the best distribution and balance in later years. The lateral branches are considerably smaller than the central leader and strong unions are formed. While this system of pruning has never been widely practiced by commercial fruit-growers, it has had some popularity, especially for dwarfs and certain varieties such as the Jonathan and members of the Ben Davis group. (See Fig. 5.)

Advantages.

1. Strong trees are produced. Crotches seldom split apart.
2. Great skill is not required to inaugurate and adhere to this type of pruning.
3. Trees like the Rhode Island Greening and Jonathan with tendencies to develop low drooping side branches lend themselves to the method.

Disadvantages.

1. It is difficult to keep trees opened up sufficiently to permit light to penetrate to the inner parts.
2. Trees usually become too high thereby making orchard operations more difficult and expensive.

Open center, or vase-shape (Fig. 6).

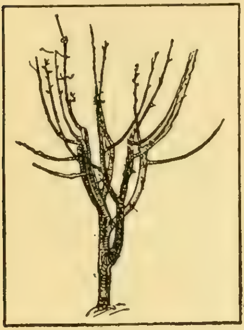


Fig. 6.— An excessively pruned young Delicious tree carved out to the vase form.

The open center type of training was the first definite system generally advocated after commercial apple-growing became established in this country on a highly specialized basis. It was for a time quite generally adopted by fruit-growers in all sections of the United States as the ideal method of training and is still advocated by some professional horticulturists and is practiced by many fruit-growers. The development of certain weaknesses in the strictly vase-shaped tree has led to a modification of this type of pruning, however.

In starting an open center tree, one-year-old whips are usually headed at 20 to 26 inches at planting time. The following winter or spring three to five well distributed branches are usually chosen to form the permanent framework of the tree, the leader being removed the first year. The three to five main branches growing outward and upward give the vase-like shape to the tree. After the first season's growth, all the leaders are cut back heavily to approximately the same height. Equal cutting is continued each year until the framework is completed, in order that no one of the main scaffold branches may attain prominence over the other. The center is kept sufficiently open to permit the penetration of light throughout the tree. The result is a spreading low-headed tree, sufficiently open to permit good coloring of the fruit.

It is usually customary to remove some 50 to 60 per cent of the first year's growth on each of the selected scaffold branches, provided the tree has made a vigorous growth. However, as previously mentioned, all of the scaffold branches should be cut back to approximately the same height, measured from the ground. In the succeeding year, two secondary branches are usually selected on each primary branch, the others being removed. The next year these secondary branches are usually shortened by the removal of about 40 per cent of the season's growth. However, the secondary branches should not be left shorter than a foot.

Pruning during the succeeding two or three seasons is along similar lines, except that the amount of heading back is lessened each year, provided the tree does not make too rank a growth.

Advantages of the vase-shaped tree.

1. The penetration of light and air is permitted to all parts of the top, which results in a high percentage of functioning fruiting wood and much highly colored fruit.
2. The method results in a low, spreading, well balanced tree.
3. The type and form is easily established and maintained.
4. The ideal may be closely approached with every one-year-old whip.

Disadvantages.

1. The trees are often structurally weak, due to the fact that the scaffold branches frequently issue from practically the same point, thus leaving weak crotches.
2. Artificial supports are frequently necessary to avoid splitting at the crotches when the trees reach bearing age.
3. When one main or scaffold branch splits off, the other

scaffold branches are weakened at the crotches and further breaking usually follows.

4. If one main branch splits off, the balance of the tree is permanently injured.

5. The amount of bearing wood is limited.

The double-headed type.

In this type of leader tree, developed in New York and West Virginia and in use there, two whorls of main branches or scaffolds are used and the framework is formed by six or eight branches arranged along two or three feet of a strong central stem. If a one-year-old whip is planted, the heading is done at about 24 to 36 inches, which leaves the lowest scaffold branch about 20 to 30 inches from the ground. After the first year's growth and before growth starts the following spring, three or at most four well distributed branches are selected and all others removed. The remaining branches excepting the leader are headed back to 14 to 16 inches in length. The leader or upright branch is left with 16 to 18 inches of new growth.

After the second season's growth has been made, two secondary branches are selected on each primary branch except the leader and the others are removed. These secondary branches are then headed back to 18 or 20 inches in length. Long willowy branches are headed back even more severely. The second year's growth on the leader is removed with the exception of the most upright development and any short spurs. About 16 to 18 inches of the new growth of the leader is left. This leaves the leader extending 2½ to 3 feet above the first scaffold.

After the third season's growth, the lateral main branches and their secondary growth are handled in a

manner similar to that following the second season's growth, except that the heading back is less severe. It is after the third year that the second story of scaffold branches is started from the central leader at a distance of about 30 to 40 inches above the first set of branches. Three or four laterals are selected for this upper story and the others are removed. The second story scaffold branches are then treated like the first ones were two years earlier. The upward growth of the leader is now suppressed and the tree is continued with an open center. It is sometimes advisable to add a third story.

Advantages.

1. The system results in a strong tree since the lateral branches are smaller than the central leader and therefore do not form weak crotches, as are likely to occur when all of the main branches are of equal size.
2. The weight of the tree is distributed among six to eight main branches well placed on a central trunk rather than among three or four branches as is the case in open center trees.
3. The trees have a greater bearing surface than do open center trees, since the space in the center is more completely occupied.
4. Sufficient light and air are permitted to all parts of the tree since on the discontinuance of the central leader above the second scaffold the top then assumes some of the characteristics of a strictly open center tree.
5. A rather low spreading top is secured and at the same time a somewhat larger tree than under the open center system.

Disadvantages.

1. In practice there is a tendency for growers to leave too many scaffold branches and thereby create a crowded condition.
2. There is danger of either the upper or lower set of scaffold branches becoming dominant unless the pruner uses skill and good judgment in maintaining the proper tree balance.

The modified leader tree.

In reacting from the two extremes embodied in the strictly " vase-shaped " tree and the central leader type, many commercial apple-growers in the leading producing regions have adopted the " modified leader " system, thus appropriating the best features in both extreme types. As the name implies, this system develops a tree of a modified leader type.

Starting with a whip headed at 30 to 36 inches, four to seven scaffold branches well distributed along a central trunk after the fashion of an ascending spiral are permitted to remain and form the framework of the tree. It is impossible to secure all of these branches from a single season's growth, from two to three being selected the first year and the remainder later. The permanent framework may not be secured short of three or four years. One point to be remembered is that scaffold branches should be spaced well apart. Branches that are only two or three inches apart will be entirely too close when the tree reaches maturity. Some growers prefer scaffold branches one foot apart. (See Fig. 7.)

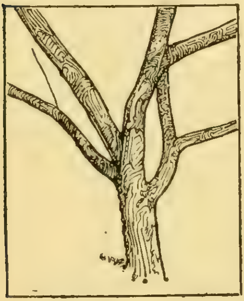


FIG. 7.— Mature Jonathan tree with common type of framework.

The leader is permitted to develop during the first three or four years while the framework branches are being selected. The first year's growth will usually consist of an almost upright branch together with several laterals. It may be possible to select two or even three well distributed

scaffold branches after the first year. All others except the leader are removed and the remaining branches are cut back. In order that the leader may dominate for a time, it is left somewhat longer than the other branches. On vigorous trees as much as 40 to 50 per cent of the leader is removed and from 50 to 60 per cent of the laterals. The whole question of heading back is a subject of varied opinion which will be discussed later.

Additional laterals will develop during the second year. One or two desirable scaffold branches may then be added to the framework. The leader and selected laterals are treated in the manner described for the year previous, although heading back is usually less severe.

The system is continued during the third and if necessary even to a fourth or fifth year. When suitable scaffold branches have been developed, the leader is removed and there remains a tree with central trunk about six or seven feet high along which are spaced three to six or even more main laterals extending outward and upward in all directions at intervals possibly of 10 to 12 inches.

Advantages.

1. This system of training results in a strong tree since the central leader is larger than the main or scaffold branches, thus leaving strong unions, which are not likely to result in splitting.
2. The weight of the tree is distributed along a trunk and among several main branches rather than among three or four branches with no central axis as is the case in open center trees.
3. The system encourages a good distribution of main branches about and along the central axis.
4. Should one main branch break or be lost because of disease, there is still a sufficient number from which laterals may be grown to fill the opening and thus preserve the tree balance.

5. Trees trained in this manner have a large capacity for fruiting.

6. Light and air are admitted to all parts, insuring fruit-spur activity and highly colored fruit.

7. The resulting tree is low headed and spreading and permits economical orchard operations.

Disadvantages.

1. More judgment is required in building this type of tree than any of the others. Untrained labor cannot be trusted with the shaping of the trees.

2. There is danger of some main branches, especially the upper ones, outgrowing the lower ones, thereby suppressing the latter to such an extent that they no longer serve as main or scaffold branches.

3. When building the young tree, pruners are apt to leave the leader too long or too short as compared with the laterals, thus destroying proper balance.

GENERAL TREATMENT OF YOUNG TREES

The foregoing has been a general description of the different types of trees, but the reader has gained little information as to what actually is done each year during the formative period of the tree. The amount of cutting back and thinning out does not vary greatly with the type of training. A more detailed discussion for the modified leader tree will, therefore, serve for the other types as well.

After first season.

If there has been a vigorous growth of more than 30 inches, the scaffold branches are shortened to about 50 per cent and the leader to 60 per cent. If growth does not exceed 20 inches, the leader is shortened to about 14 inches and the laterals to 10 or 12 inches. When possible, the

secondary laterals should be developed on the main scaffold branches at a distance not closer than one foot or greater than 20 inches from the trunk. When the scaffold limbs make slow growth, it may be necessary to delay the development of secondary branches by cutting back the scaffold limbs to two or three buds.

After second season.

Heading back should be less severe after the second season's growth. Some recommend leaving about 20 inches new growth on the leader and about 15 inches on the scaffold branches. Others think that very little heading back should be done after this time regardless of the amount of growth. There is a growing sentiment that trees should be headed back very little after the second or third year. It is of course necessary to check wayward and crossing branches. Furthermore when growth is vigorous, heading back may be necessary in order to encourage stockiness. If long rangy growths are left, they will not be strong enough to carry heavy loads of fruit in later years. During the first two or three years, certain of the main branches may outgrow the others, in which case the stronger growing ones should be headed back more severely than the weaker growing ones.

After third season.

The main laterals may be cut back lightly to about the same length, slight predominance being given to the leader if it is retained. When the modified leader type is being followed, the third year may see the development of a sufficient number of scaffold branches. If not, the

leader is maintained for one or more years, at which time it is removed in order to open up the center of the tree.

Small side shoots and fruit-spurs developing in the middle of the tree during this time should be left. Such wood is productive of early fruit. Furthermore, an abundance of foliage and small twigs are necessary to protect the main limbs from the sun and also to aid growth. There must be plenty of foliage and twig growth if young trees are to produce wood.

VEGETATIVE, TRANSITORY AND FRUITAGE STAGES

A tree may be said to pass through three distinct periods: (1) formative period, (2) transition period, and (3) fruiting period. The treatment, both in regard to pruning and soil management, changes materially with each of these periods. It is during the formative period that the tree devotes its energies to the formation of wood growth. The proper selection, distribution and training of scaffold branches during this time determines the ability of the tree to bear and carry heavy loads of fruit in later years. The length of the formative period is usually from four to six years, depending on the region and treatment provided.

Transition period.

Although less distinct, this period is critical. Between the fifth and eighth year the tree is undergoing a change from vegetative to heavy fruit production. The exact age will vary with the region, variety and treatment. Some varieties may not pass through this period until they become ten or twelve years old. Other varieties and particularly when grown under irrigation begin to bear heavily at six and seven years.

Pruning during the transition period should be light and should consist almost entirely of thinning out, with little or no heading back. The thinning out should be confined largely to the top and ends of the branches and to shoot growths of the previous season. If the tree is becoming too thick, two- and even three-year-old branches should be removed.

Too often the small lateral limbs and fruiting wood toward the center of the tree are removed, thus forcing all the fruiting area toward the tip ends of the limbs. Again, tops frequently become so dense that the inside spurs slough off due to lack of sunlight and air.

The fruiting period.

All pruning during this period is to develop and maintain a liberal supply of fruiting wood, well distributed throughout the entire tree. This pruning will consist largely of thinning out branches in order to maintain a liberal supply of functioning fruit-spurs, and in order to improve the quality of the fruit produced. Weak or wayward branches should be removed. The tree should be kept open and shapely and in a vigorous growing condition. Regular annual pruning is essential.

Fruit-buds.

Fruit-buds may be regarded as the actual fruit manufacturing machinery of a tree. In case of the apple, the fruit is borne mostly on spurs which develop from lateral buds on the shoots of the preceding season. In certain varieties of apples, such as Jonathan, Gravenstein, Newtown and others, much of the first crop of fruit-buds is borne terminally on shoots. Axillary buds are also borne

on one-year-old wood, but on the side of the shoots instead of at the tips. Spurs are nothing more than very short branches on which terminal fruiting buds are borne every alternate year, under favorable conditions. These buds are usually developed from branches two years and older. If fruit-spurs are properly cared for, they may live and produce fruit-buds in alternate seasons for at least eight or ten years.

All lateral buds of the shoots of any one season do not develop into spurs the following year. Some of them grow out into new or branch shoots, many others remain dormant. Spurs are largely developed from the large, plump, vigorous lateral buds.

Having developed a large number of spurs evenly distributed throughout the tree, it is absolutely essential to conserve this fruiting wood. In a great many cases, the fruiting machinery toward the center of a tree fails to produce fruit. This is due principally to the lack of sunshine and air, two factors on which a spur is entirely dependent for its ability to function. The pruning, then, should be with the idea of leaving spurs distributed throughout the entire tree and of getting plenty of sunlight and air to each individual spur. This can be accomplished by thinning out as opposed to heading back. It permits more light to percolate through the tree and gives the leaves in the center a better chance to manufacture the food materials necessary for the formation of large strong fruit-buds.

Changing system of pruning.

After the form of a tree has once been established, it is not considered advisable to change its type unless its form

may be modified without drastic pruning. An open center tree, for example, should be continued as such. A modified leader should not be removed in later years in order to develop an open center tree. The type of training should be established during the first three years and this same style should be followed out year after year.

FIG. 8.— Common type of trunk and lower framework of Rome Beauty under northwest conditions.

Trees four to ten years old that have been pruned with no definite type in view often present some very perplexing problems. The number and proper distribution of scaffold branches should be definitely chosen and part of the most objectionable branches removed the first year. In cases where there are a dozen main branches when half that number would suffice, it may be advisable to select only six for the permanent framework. The removal of the objectionable branches should be distributed over a period of two or three years, however.

Young trees which have been neglected should be cut back rather heavily to encourage the development of good strong laterals near the base of the limb. When heading back has been neglected and the result has been long rangy branches with weak lateral development, it may be necessary to cut back into two- or three-year-old wood. When a good side branch is available, it is advisable to cut back to the side branch instead of to a bud.

Crossing and interfering branches should be removed. If too many long parallel limbs have developed, part of them should be taken out in order to allow the remainder freer development. Two limbs which emerge from a common point usually result in a weak crotch, a condition which can be overcome by unequal cutting, i. e. cutting one limb heavier than the other.

Bearing trees.

A tree that has been handled properly up to the bearing age, that has its framework well established, and its fruiting machinery well distributed, will require little subsequent annual pruning. As previously described, the treatment of a bearing tree, whatever the type, will consist largely in thinning out the new growth near the tops or outer parts of limbs to allow a good circulation of sunlight and air. Wayward and crossing branches should be checked or removed.

Gardner, of the Missouri Experimental Station, likens the fruit-spur to a factory. He refers to the spurs as little machines. The raw materials from which fruit is produced come from the soil and air and are manufactured into a finished product by the leaves through the aid of sunlight. The latter is classed as the cheapest, most abundant and yet most valuable form of motive power. The performance of every spur is dependent on a certain amount of sunlight. (See Plate XVII.)

Each individual spur relies on its own leaves for the manufacture of the starches and sugars which it uses. It cannot draw on other nearby spurs or on other parts of the tree for maintenance. As the manufacture of food materials is absolutely dependent on light, the production

Plate XVII.— This tree has produced as high as 20 barrels of fine fruit in one season and averages about 10 barrels a year. Note the good distribution of the branches.

of fruit-buds and fruit is likewise dependent on sufficient quantities of light.

Thinning out the top and outer portions, then, is the most effective means of letting light in to each individual spur, thereby distributing the motive power necessary to develop activity within each individual spur and increase the amount of fruit produced. The removal of a few large limbs near the ground only leaves large holes and open spaces. The cutting of lower limbs and those near the body of the tree does not permit sunlight to enter into the parts where it is most needed nor does it permit the distribution of sunlight and air in sufficient quantities to modify the functioning of fruit-spurs. Removing large limbs leaves vacant spaces and admits sunlight in shafts rather than allowing it to penetrate evenly throughout all parts.

It is better to remove many small branches in thinning the outer parts of trees. This leaves the outer fruiting wood evenly distributed and still open enough to permit the entrance of sunlight and air. The removal of small branches requires time and makes it necessary for the pruner either to use a ladder or climb well out near the ends of the main branches, but this careful work will prove profitable.

Distribution and establishment of fruiting wood.

Too much emphasis cannot be laid on the distribution and establishment of functioning fruiting wood throughout the entire tree. It is not uncommon to see trees which have been stripped of all fruiting wood except near the ends of the branches. For example, limbs 20 to 25 feet long bear all their fruit from within 5 or 6 feet from the

tip, the balance of the limb being a "boarder" and living at the expense of the productive area. It is highly desirable to have several well developed laterals along the scaffold branches in order that the fruiting area may be brought nearer the ground.

TIME OF PRUNING

No concrete rules can be laid down as to the best time for pruning, as no one time will best meet all conditions. Pruning in most sections may usually be practiced in any favorable weather in the dormant season.

In the Virginias and sections of the Pacific Coast, pruning is done from November to early April, while in the New England and middle western states, most of the work is during the spring months. Generally speaking, a slight preference should be given to pruning in late winter and early spring, because the wounds heal over more readily. Many growers are prejudiced against pruning when the wood is frozen. Some maintain that drying out or dying back is likely to result from early winter pruning, but the writers do not know of serious injury of this nature in bearing trees.

If one has a large acreage to prune, he should start work in the older trees in the early winter and reserve the younger trees for the late winter and spring pruning. Some growers hesitate to prune when growth is about to start in the spring, feeling that injury may result from bleeding. However, the writers know of no serious injury resulting from pruning apple trees at this time.

Summer pruning has received much attention in recent years but the results of investigations have been somewhat confusing. Summer pruning may be practiced to advan-

tage in training the framework of a young tree. It may also increase fruit production if timed correctly. However, so many varying factors affect the time element that it is impossible to give exact dates at which summer pruning may be done to increase fruit production. The average grower should refrain from inaugurating this practice until a better understanding is had of its effects. Water-sprouts and a few superfluous branches may be removed to advantage during the summer months.

PRUNING TOOLS

The tool equipment will vary with the man and with the type of work. In the eastern region practically all of the labor is done with a small hand shears and a saw. With these two tools, a pruner can do practically all that will be required in bearing trees and most of the work in young trees.

Cheap shears and those with coil springs are undesirable. The former are easily sprung and the latter easily broken. The shears should be 7 to 9 inches in length, the latter usually being preferred.

A saw on which the teeth are set to cut on the "pull" is less tiring to the pruner. Saws with teeth on both edges are objectionable since they frequently injure the bark. In some sections a swivel or hack saw is used. This type is a modification of a butcher's saw equipped with swivels that permit very thin, narrow, fine-toothed blades being set on the bias. It cuts rather slowly in the case of large limbs, but is particularly good for small cuts and for removing limbs in tight places. The cuts made are clean and smooth.

Pole pruners, 6 to 10 feet in length, are useful in prun-

ing the tops of trees six to ten years old, but work with this tool is slow and cutting lacks precision.

Lopping or wooden handled shears are popular for work on young trees and also for working the lower parts of old trees. However, their use becomes somewhat awkward in the upper parts of bearing trees. The double leverage type of "loppers" is desirable, 20 to 26 inches being the preferred length.

WOUND DRESSINGS

Some difference of opinion exists among growers as to the practicability of the use of dressings for protecting wounds. Certain experiments have shown that undressed wounds healed over more rapidly than dressed ones. However, for nearly all wounds paint is most desirable, white lead or white zinc thinned down with linseed oil having given the best results. Tar or creosote is sometimes preferred for large wounds since these substances are considered better preservatives than paint. The heartwood of a large wound will have to stand many years before it is completely healed over.

Wounds in vigorous growing trees heal over more readily than those on trees of low vitality. The painting over of cuts less than one inch in diameter is not recommended.

THINNING

Although practiced very extensively in some parts of the country and particularly in the West, many growers are slow to adopt thinning, and yet it is essential to the production of high-class fruit. Once a grower has carefully thinned his fruit for a few years, he needs no further

proof of the fact that this is one of the most important and profitable of all orchard operations.

For many years the apple-growers in the Wenatchee and Yakima valleys, Washington, have made thinning a general practice. Cost production studies indicate that the largest yields and greatest profits have been secured from well and carefully thinned orchards. The same may be said for orchards in all other parts of the country where this practice has been given a thorough trial. In the Middle West and East, however, the grower who thins his trees is the exception rather than the rule. The cost, together with a lack of knowledge and appreciation of the great benefits to be obtained from thinning, are the principal reasons which deter most growers from following this practice. Unquestionably it involves considerable expense, particularly with a full bearing orchard in a heavy crop year. A heavy outlay of expense in any single year might be somewhat disappointing. Thinning is an operation incident to the production of high-class fruit. It should not be sporadic, but should be practiced in every heavy crop year. When fairly competent labor may be secured at reasonable rates, it will be profitable. As the competition in the growing of high-class apples becomes greater, thinning will become more and more a general practice in every commercial region in the country.

In listing the advantages of thinning it is found that it: (1) increases size and quality of fruit; (2) reduces handling costs such as for picking and packing; (3) prevents overbearing and promotes vigor of tree; (4) encourages annual bearing; (5) increases average annual yield; (6) reduces amount of cull and low-grade fruit since inferior, diseased, or worm-eaten apples may be removed; (7)

secures uniformity of size and market quality of fruit; (8) insures a high price for crop.

(1) The statement that thinning tends to increase the size and quality of the remaining fruit will go unquestioned. Not only are the apples larger, but the color of fruit on well thinned trees is noticeably better than on overloaded ones. It is manifest that well developed specimens of good size and color will be of a superior quality and flavor.

(2) By reducing the number of apples to be picked and handled at harvest time, the harvesting costs are materially lowered. If apples are not removed at thinning time, they must be picked at harvest at an even greater expense. Many of the culls and inferior fruits can be removed in thinning and this will not only tend to improve the quality of the fruit, but will reduce the sorting cost at harvest time.

(3) If trees are left overloaded, their vitality is impaired; branches are quite likely broken; and the prospects for the next year's crop are very much poorer than if the tree had been properly thinned. It is difficult to measure the exact value of thinning as affecting annual yields and yet it is a notable fact that thinning unquestionably stimulates annual bearing. Many well thinned orchards in the Northwest bear heavy crops annually while most unthinned orchards tend to bear biennially.

(4) To claim that thinning reduces the tax on the vitality of the tree and yet maintain that it actually increases yield may seem contradictory. Unquestionably it increases average annual yield and it is a fact that increased size in fruit usually more than makes up for

reduced numbers. Furthermore, by more even distribution the tree may better hold its load.

(5) It is possible in thinning to remove wormy, stung, diseased or otherwise inferior fruits and in this manner greatly reduce the percentage of cull fruit and in some ways check the spread of the injury.

(6) Uniformity is one of the most desirable qualities in marketable apples. Thinning, of all orchard operations, is the one which directly influences uniformity in size and marketable quality of fruit.

(7) When the grower is striving for an abundance of highest quality fruit, thinning unquestionably pays. It increases the percentage of high-grade fruit and thus insures a higher net price. Cost of production a bushel will be lowered even though cost an acre may be increased. If a grower has expended heavily for spraying, pruning and other operations, he can not afford to neglect thinning in years when his trees tend to overbear.

Time and method of thinning.

Thinning should not be undertaken until after the June or May drop, as in some of the more southern regions, has occurred. When the apples are about the size of walnuts, the natural thinning of the fruit has largely ceased and artificial thinning may be begun profitably.

Often many growers have a market for early cull fruit or sell it for by-product purposes. In such instances thinning may be delayed until perhaps August, at which time the cull or inferior fruit may easily be picked off. Still other growers thin their apples by making several pickings for commercial purposes, picking off the best

and most matured apples for market and allowing the others to remain. Such practices can hardly be classed under the head of thinning, although they may be profitable in some instances and may be practiced in addition to early thinning.

The common practice in thinning is to start early after the June drop and pull or clip off all apples according to varying rules of spacing. Some growers leave the apples at a minimum of 4 inches apart, others 6 inches and still others 8 inches apart. This distance will depend largely on the variety, its tendency to cluster, and whether or not the apples of the variety are normally large or small when mature. Generally speaking, spacing 6 inches is a safe rule to follow.

Many varieties of apples have a tendency to produce their fruit in clusters and often thinning the cluster to one apple is practically all that is necessary. In any case, if systematic thinning can not be practiced, the clusters should at least be thinned as this prevents much insect injury and promotes general uniformity of the fruit. The amount of thinning will depend on the individual tree, the variety and the amount of fruit on the tree. No definite formula may be laid down. The usual method of thinning apples is to pick the fruit off by hand, sometimes putting it into a bag, but usually permitting it to drop on the ground. Many growers, particularly in the Northwest, prefer thinning shears, of which several types are on the market. The advantage to be gained in using thinning shears is that the apples are clipped instead of pulled off and for this reason fruit-spurs are not likely to be broken or damaged.

Cost of thinning.

The cost of thinning will depend on several factors, such as the variety, size of tree, kind of labor employed, method used, size of the crop and the vigor of the tree. The average man thins from three to twenty trees a day. In the Northwest one hour to a tree is considered an average amount. It must be remembered, however, that the Northwest trees are much smaller and the fruit easier of access than in the older orchards of the East and Central West. In old orchards, heavy with fruit, from three to five trees is a day's work. It would not do to figure averages on this basis as often many trees do not need much thinning. It requires about sixty hours an acre to thin the better Wenatchee orchards. Very little thinning is done in New York and Virginia, but if the trees in these regions were thinned as systematically as in Wenatchee, the amount of labor expended would be about the same to the acre despite fewer trees. The average grower is safe in assuming that it will pay him to spend on thinning an amount equal to twenty-five cents a barrel for every barrel of fruit produced. The operation usually costs less than this amount.

CHAPTER XIII

RENOVATION OF OLD ORCHARDS

Throughout the country and particularly in the eastern and central western states are many thousands of apple trees which at present have little or no commercial significance. Many of these are in the old farm orchards, the average of which includes at most but a few acres of poorly kept and very often neglected apple trees. There are, however, a great many orchards originally set out for commercial purposes and later neglected. It is to this latter acreage that the discussion on renovation will particularly apply.

Greatest possibilities for renovation are offered in Ohio, Pennsylvania, and the northeastern states, also in many sections of the Middle West. In southern states the old neglected orchards are for the most part of such small size and are so inaccessible as to offer slight inducement for successful renovation. The problem of renovation requires exceptionally careful study if one is contemplating this method of entering the business of growing apples commercially. In recent years many far-sighted individuals have been able to purchase neglected apple orchards and by renovation make much quicker returns on the money invested than would have been possible had a young orchard been set out and the owner waited for the latter to come into bearing. Such opportunities still ex-

ist. It is somewhat surprising in visiting well-known commercial regions to see a large number of orchards which receive little or no care, yet which under proper management could be made to yield a profit. The above statement is not to convey the idea that it is profitable to attempt the reclamation of all old farm orchards by the process of renovation. Very many trees are beyond the period when they may be reclaimed profitably.

It requires considerable experience and nicety of judgment to determine what orchards may or may not be successfully renovated. In the first place, it is essential that the orchard should be large enough to meet the expense of proper equipment such as the spray-pump, and to warrant some detailed attention from the owner. It is doubtful whether an orchard of less than five acres, or one in which many trees are missing, can ever be renovated successfully and put on a profitable commercial basis. Smaller orchards, of course, might well be restored for home use.

Commercial orchards to be renovated should include varieties for which there is a demand. Plantings should be accessible to market and labor. However, one might profitably restore an old orchard in a locality in which it would scarcely be advisable to set new plantings. An established orchard always enjoys an important advantage from being already in bearing.

The following suggestions are offered with regard to the process of renovating an old orchard and apply as much to the home orchard as to commercial plantings:

General treatment.

All dead wood and cankers should be cut out and the trunk of tree thoroughly scraped with a hoe or similar

tool, being careful not to injure the tender inner bark. This scraping removes the hiding places for many orchard pests. After scraping, some advise that the trunks should be whitewashed. Unquestionably such treatment would be beneficial, although it it not recommended as necessary.

In cutting large limbs, it is best to make two cuts, the first about a foot above the last in order to prevent splitting or otherwise injuring the good wood below the final cut.

It is well to disinfect large wounds with copper sulfate or corrosive sublimate, after which a coat of asphaltum tree paint or white lead is advisable to protect the tree against decay and from the ravages of insects and diseases. When small limbs and twigs are being headed, one should cut to a lateral growth, otherwise the remaining stub dies and decay follows.

The chances are that in old neglected orchards many holes will be found in the trunks of the trees where limbs have been broken or cut off in years gone by, where decay has set in. Very often trees may be saved if the decayed wood is thoroughly cleaned out. Occasionally such cavities are filled with cement, care being taken that all water and wet wood is removed first. As a general rule, such treatment is not practicable.

Pruning.

In shaping or pruning a tree after the dead wood has been removed, a number of precautions should be borne in mind.

A common mistake in renovation is to sacrifice much of the fruiting area by removal of a large part of the top with a view to bringing the head closer to the ground.

It takes several years to develop fruiting wood and it may be advisable to thin out rather than remove the already existing fruiting wood.

Very often, however, because of excessively high trees, severe cutting back and thinning out of the remaining tops is necessary. Even in such instances it is unwise to remove too large a portion of the fruiting wood, even though such wood may be found, as it very often is, at the tips of the larger branches. The orchardist should encourage lateral growth, but should avoid the sacrifice of too great a part of the fruiting area. It is usually advisable to distribute the heavy pruning over a period of several years in order to preserve the balance between the roots and the top, and to prevent sun-scald on the larger limbs through exposure to direct sunlight.

It is important that the outer parts and tops of all trees should be well thinned by working from the top and tips of the branches downward. This provides for penetration of sunlight and allows distribution of fruiting wood throughout the entire tree. It is common to see a grower start with the lower trunk limbs and prune severely as far as he can reach conveniently, leaving the outer part of the limbs to bear all the fruit. Ladders are almost indispensable in thinning and heading back the tops.

Each limb should be treated somewhat as a separate tree. Laterals should be thinned out and the remaining ones spaced as on the trunk, special effort being made to bring fruiting area nearer the ground. By thinning out the brushy tops, water-sprouts may be encouraged farther down on the main limbs. The following year the water-sprouts should be thinned out to a distance of 18 to 24 inches apart and cut back severely so that they will throw

out laterals and eventually lower the fruiting area. In pruning water-sprouts, the leader should be cut slightly less than its laterals, a safe proportion being to cut the leader 35 per cent and the laterals about 50 per cent.

Although it is advisable to distribute the heavy pruning over a period of three years, the orchardist should bear in mind that the heavy cutting of one main branch does not necessarily produce the vigor necessary for fruiting on the remaining limbs. If one branch is pruned heavily, the water-sprouts will come on that particular limb and not on the others. Therefore, a general moderate pruning throughout the top, with careful attention given to thinning out the smaller fruiting wood, will serve to encourage fruiting generally throughout the tree and to afford an opportunity for converting water-sprouts into new fruiting wood in the lower part of the tree. Systematic pruning must be followed for a period of several years if renovation is to be made effective.

Spraying.

After pruning the next step in renovation is thorough spraying. Old trees are nearly always badly infested with scale as well as with other insects and diseases. A thorough application of lime-sulfur is a necessary clean-up measure. After the dormant winter spray, the same regular spray program should be followed as is necessary in commercial orchards of the region. It is particularly important in the case of old trees to have a tower on the spray rig in order that the spray will reach the topmost branches. The importance of spraying can not be emphasized too strongly as essential to the proper renovation of the orchard. (See Chapter X.)

Soil management.

Thorough cultivation is usually the first step in renovation, although in some instances deep plowing may result in cutting off many of the feeding roots, especially when an orchard has been in sod for some time and the roots feed close to the surface. If the roots are too greatly disturbed, the trees may be seriously weakened. Thorough discing when possible is always safe and satisfactory. Plowing is to be preferred if it can be done without destroying too many of the roots. Early cultivation is best and should be performed as soon in the spring as possible. After thoroughly working the soil, it is very often advisable to sow a leguminous cover-crop in order to supply humus and nitrogen when these two essentials have become depleted.

In many instances inter-crops have been continuously grown in old orchards with the result that the soil is decidedly lacking in one or more elements of plant-food. When available, liberal applications of barnyard manure, from 10 to 18 tons to the acre, will aid in restoring soil fertility. When the soil seems generally weak and deficient, an application of complete commercial fertilizer, consisting of 6 pounds nitrate of soda, 8 pounds acid phosphate and 3 pounds muriate of potash to a tree, may be considered a very liberal treatment. Fertilizer experiments emphasize the efficiency of nitrate of soda used alone. A 5-pound application of nitrate of soda will be generally profitable on weak trees. When commercial fertilizer is applied in conjunction with manure, the above amounts to a tree may be cut to about half.

In summarizing, the three important steps in orchard

renovation are: (1) careful pruning; (2) thorough spraying; (3) thorough working of the soil with the possible addition of commercial fertilizer.

CHAPTER XIV

HANDLING THE CROP

The handling of the crop includes the operations from the time the fruit is ripe until it is put on the market. Special care is necessary in picking and packing in order that the apples may reach the market in good condition.

PICKING (PLATE XVIII)

The time of picking varies greatly with the variety and with the season. Other influences, such as age of trees and cultural practices, may also affect the time of this operation. It is generally thought that fruit comes to maturity earlier on older trees than on young ones; also that apples grown on sod land should be picked sooner than those in cultivated orchards. As a rule, over-maturity is to be feared more than immaturity, although both conditions may be disastrous. Maturity in most instances means hard ripe and not eating ripe. Since the time of picking has so much to do with the keeping qualities of the fruit, it is important that the ripening tendencies of each variety be studied in every particular locality. The following points should be taken into consideration in order to determine the correct picking time for different varieties of apples: 1. The ease with which the fruit separates from the spur; 2. the red color; 3. size; 4. color of seeds; 5. tendencies of certain varieties to drop.

1. One of the most valuable guides in determining the time of picking is the ease with which the apple separates from the spur. Much damage can be done if the apples are picked too soon, for in such circumstances the picker will probably destroy or break off many fruit-spurs. The grower must sacrifice size if the fruit separates readily from the spur, otherwise he may suffer from heavy dropping or over-maturity of the fruit.

2. In most cases, the amount of color is the grower's guide in determining time of picking. In this connection it should be remembered that in bright seasons the apples have a tendency to color early and for that reason there is the danger of picking too soon. In damp cloudy weather, coloring may be checked and under such conditions there is danger of waiting too long before harvesting. Very often two pickings are advisable for such highly colored varieties as Winesaps. If the better colored specimens are harvested in the first picking, the remaining poorly colored apples will benefit by greater exposure to the sunlight. It must be remembered that an added picking represents a considerable expense warranted only in the case of high quality crops, when the added color and size mean a considerable increased price for the product. Investigations [1] have revealed that in the case of red apples the ground color which underlies the red color or blush is the most reliable indication of maturity. In immature fruits this color is green. Before the apples are ready to pick, the ground color should have turned to a white or very light yellow. The dark yellow ground color indicates over-maturity. The very common mistake of leaving such

[1] Bull. 587, U. S. Dept. Agr.

Plate XVIII.— Showing method of picking practiced in Virginia, particularly in the Piedmont section where a crew of pickers will commonly pick from a single tree. An inefficient method.

varieties as Jonathan and Esopus too long on the trees results in a much shortened life for the fruit in storage.

3. For green varieties and particularly early green apples, size is an important factor. The grower should not wait for the yellow ground color, otherwise he will lose through over-maturity of his fruit. If two pickings are made, it will be found that the apples left on the tree will quickly benefit in size by the removal of a portion of the crop. It must be considered that size will vary according to crop, age of trees, and season, so that no definite idea of the proper size at which to pick can be given.

4. It has been recommended that apples should not be picked until the seeds have turned brown. While the color of the seeds may be taken as an indication of maturity, it should not be considered as always reliable. The seeds should always be brown before the apples are picked, but the brown color of the seeds does not necessarily indicate maturity. In other words, immature fruit may have brown seeds.

5. Such varieties as McIntosh, Wagener, and Tompkins King tend to drop before maturity, and Stayman, Wealthy and Grimes to drop badly with the wind. The grower should watch these tendencies and should regard heavy dropping as an indication of need for immediate picking.

No other operation in the physical handling is more essential to the life of the fruit than careful picking. The pickers should be impressed with the importance of preventing bruises, punctures or abrasions of the skin, since such injuries permit the entrance of serious storage decay. The fungi which cause most of the storage decay can not injure sound fruit. Careless picking hands may

pull off the fruit-spurs and seriously injure the tree in climbing about or in carelessly manipulating the ladders.

Delays in picking and also delay before storage often involve heavy loss. After the fruit has been picked, it should be put in storage as soon as possible. Two or three days' exposure to warm sun in the orchard after picking will cause the apples to ripen rapidly and the life of the fruit will be materially shortened. Immediately stored fruit is always brighter and firmer than that which is left in the orchard for several days after picking.

Contract picking versus day labor.

In connection with the operation of picking, it is important to consider the contract system as compared with day labor from the standpoint of efficiency and economy. The principal objection to contract labor in picking is the danger of careless handling of fruit when the picker tends to sacrifice carefulness for speed. Most growers have avoided contract picking, although the practice is gaining somewhat in popularity in some regions, particularly where labor is scarce. Cost production studies have revealed that the contract picker working by the piece will pick on the average of at least 25 per cent more apples in a day than will the day laborer. If competent labor can be secured and carefully overseen, contract picking may offer an opportunity for speed and considerable saving in handling the crop.

Picking utensils.

Various types of picking utensils are in use and each has its advantages and disadvantages. The canvas bag, suspended by straps from the shoulder and opening at

the bottom so that the apples may be rolled out into a box or barrel, has become the most popular picking utensil in the Northwest. Some criticism is voiced against the picking-bag on account of the danger of bruising the fruit. When the picker is climbing about on ladders, apples in a bag may be knocked against the ladder or subjected to more shaking or rolling about than if placed in pails. The chief advantage of the picking-bag is that it leaves both of the picker's hands free for picking.

A pail with a canvas bottom which may be opened in emptying possesses some of the advantages of the bag and may afford better protection for the fruit. The round half-bushel basket is a very popular picking utensil throughout the East and Middle West. Its value may be enhanced by lining the sides with corrugated paper or padding the bottom to prevent bruising the fruit. Wire hooks on the handles of pails or baskets will aid in the hanging of these utensils on the ladder or tree.

If the picker is obliged to walk a considerable distance to a sorting-table, as is the case where fruit is packed in the orchard, a pail or basket is sometimes preferred to the picking-bag, for in such instances the receptacles are filled and left at the bottom of the tree to be carried later to the packing-table. A waiter should be employed to carry the fruit from the base of the tree to the orchard sorting-table, since this workman will carry two or more baskets whereas the picker will make the return trip with only one. Where the crop is handled through the packing-house, receptacles for the picked fruit should be distributed throughout the orchard in order that the picker will not lose time in emptying his bag or pail of fruit. In all cases, the picker should be warned against allowing the fruit to drop into the

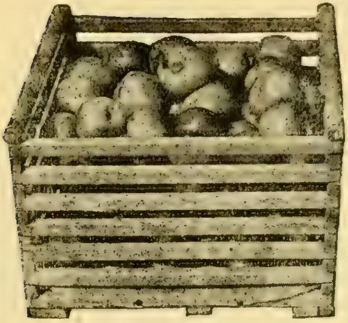


Fig. 9.— Slatted crate used very generally in the eastern states for bringing apples from orchard to packing-house.

box or onto the table with sufficient force to cause severe bruising. A low orchard wagon with springs is recommended for hauling receptacles of loose fruit. (See Fig. 9.)

The pointed ladder is the most efficient type for picking in among the branches since it can be placed against a fork or limb without injuring the tree. Step-ladders with a single prop are useful in picking from the outside limbs or from small trees.

PACKING (PLATE XIX)

Since there are two somewhat divergent systems for grading and packing the barreled and boxed apples, the two general methods will be discussed separately. Throughout the East and Middle West, much of the packing is done in the orchard although sheds are increasing in number and popularity in nearly every commercial apple region. Western growers early showed a preference for the packing-house, since very exacting labor and good equipment are required in maintaining the high standard of the boxed pack.

Sorting and packing barreled apples

Until recently most of the barreled apple crop was packed in the orchard with the aid of portable packing

equipment. The packing-shed is growing in popularity throughout the East and Middle West, but many commercial apple-growers still pack out their crop in the orchard, and this operation, therefore, must be given separate treatment.

Orchard packing.

When sorting and packing is done in the orchard, the equipment usually consists of either a portable slatted table or a canvas or burlap-top table.

Of the above two types, the slatted table is most commonly used. Very often these tables are equipped with wheels in order that they may be moved about easily in the orchard. The top of the average slatted sorting-table tapers from three to four feet at one end to one to two feet in width at the other end. The table also slopes so that when the fruit is poured on at the wide end, it rolls down past the sorters to the narrow end, and there is lowered into the barrel by means of an apron. The upper end of the table top should be padded heavily to prevent bruising of the fruit. Leaves and brush drop to the ground as the apples roll down over the slatted top. Sorters stand at the side of the table, and when only one grade is being packed out, as is usually the case, they remove only the culls and rots. When two grades are being packed, the additional grade is picked out as the fruit passes over the table, and is placed in barrels alongside the sorter. The packer stands at the lower end of the table and feeds the apples into previously faced barrels, at the same time assuming part of the responsibility for the grade.

The slatted sorting-table is an example of cheap portable

equipment, but in its use there is danger that inferior fruit will crowd past the sorter. Although the slatted table is widely employed throughout the East and Middle West, it seems probable that its place will be taken more and more by the mechanical sizer or burlap-top table.

Some barrel apple-growers, and particularly those interested in a more careful pack, employ the canvas or burlap-top table, which is usually about three feet high, three feet wide and six or eight feet long. The apples are emptied directly from the tree onto the top of the table. Sorters then grade out the fruit, usually placing it in baskets or receptacles according to its grade. Under this system, two grades are ordinarily packed out, the culls being thrown to one side in a pile or placed in separate barrels. The packer stands behind the sorter and fills previously faced barrels with the fruit according to its grade.

The use of canvas or burlap-top table facilitates more careful handling and sorting than the slatted-top table. In the case of either, the picker usually carries his own fruit directly to the table, although in some instances the work of transferring fruit from the base of the tree to the packing-table is done by additional workmen. As previously pointed out, the latter system is more efficient.

Before discussing packing-house equipment, it should be mentioned that portable sizing machines have been used to some extent in orchard packing.

Packing-houses for barreled apples.

While orchard packing still predominates, the rapidly increasing number of packing-houses throughout the barrel apple states is a distinct sign of progress. Some ad-

vantages of a packing-house are: (1) Centralization of packing operations, no time being lost in moving equipment about the orchard; (2) packing may continue uninterrupted during inclement weather; (3) improved sizers and other labor-saving devices may be installed economically; (4) packages for the fruit are kept cleaner than if handled in the orchard.

The eastern apple-grower has come to rely on cold storage rather than common storage in holding his crop for any length of time. For this reason, common storage in connection with packing plants is not recognized as such an important feature as in the West. The grower either sells his winter apples immediately or places them in cold storage. Therefore, the packing-shed in the barreled apple industry assumes more the nature of a shelter for centralized packing operations.

Eastern and middle western apple packing-houses might arbitrarily be classified in three groups: (1) Those providing a mere shelter for either the inclined slatted-top or canvas-top sorting-tables; (2) those which not only provide shelter for the packing operation, but which have a small sizing machine and possibly certain other labor-saving devices; (3) the large improved packing-shed with a daily capacity of 300 to 1,200 barrels of apples.

In the third class are the larger and best equipped mechanical sizers, fitted with conveyer belts, improved bins and other equipment calculated to insure the greatest speed and efficiency in handling the crop. With such packing-houses, the fruit is usually delivered from the orchard on to a receiving platform or possibly directly on to a receiving belt which carries it past the sorters and delivers it directly into the sizing mechanism. The

sorters stand beside the conveyer and grade out the fruit as it passes them. More improved sizers permit the grading and sizing of two and even three grades simultaneously. The sorting is accomplished by dividing the grading belt lengthwise with strips which serve as partitions to separate the different grades. A separate set of bins is then required for each grade.

The machines now most commonly used throughout the East size but a single grade, the fruit being sorted according to one of the following two practices: (a) Only culls and rots are removed, the remainder being allowed to go into a single grade, in which case the smaller sizes are packed out as No. 2's and the larger sizes, usually from 2½ inches up, are called No. 1; or (b) not only are culls removed but also a second grade based on quality, the latter being diverted into a single bin without sizing. The first grade then proceeds along the conveyer belt to the sizing mechanism, the apples being delivered in bins according to their respective sizes.

The growing tendency in the largest barreled apple districts where careful grading is practiced, is to size the first grade to quarter inch sizes. This makes a more attractive pack than one in which all sizes above a stated minimum are packed into the same barrel. In addition to the advantage of increased attractiveness of pack, the more exact sizing makes possible the handling of the fruit through more bins, and in this way eliminates congestion in any one bin. However, unless the volume of fruit handled is great enough to keep several packers busy when the apples are distributed among three or four bins, it is not advisable to attempt such exact sizing.

In any of the above practices, the fruit is taken out of

its respective bin and placed in previously faced barrels. An additional workman then nails and stamps the barrel and places it in a position ready to be loaded on the cars or hauled to the shipping station.

Some desirable features for the packing-shed under eastern and middle western conditions may be summed up as follows: (1) It is highly desirable that the packing-shed should be convenient to a railroad loading station. In the case of community packing-sheds, it is always essential that a site be selected where the fruit may be loaded immediately on cars. In such cases, the roof should slope to the back to permit of later additions to the building. (2) Storage space should be provided for empty barrels. This may be done conveniently by providing a loft overhead with chutes for delivering the barrels to the packing-table. (3) It is highly important that attention be given to proper lighting. Light shafts over the sorting-table may be necessary. It is impossible to sort and grade fruit properly in darkened rooms. (4) It is usually advisable that larger packing-sheds be equipped with mechanical sizers. (5) Storage space should be provided for loose fruit so that the packing operation may continue for a day or more without continued supply from the orchard. There should be storage also for one or more days' run of packed apples so that it will be unnecessary to ship odd lots of fruit. (6) An important point in packing-house arrangement is to provide a conveyer or some means for preventing the culls from accumulating around the packing-table. (7) A receiving platform should be built at a convenient height for unloading fruit from wagons. When mechanical sizers are used, it is advisable to have the receiving platform at the same elevation as

the sizing machine. This obviates the necessity of lifting the fruit in feeding the sizer. (8) In passing through the different packing-house operations, the fruit should continue in the same general direction. (9) Ample floor space should be provided. Congestion greatly slows up packing operations. (10) A building more nearly square is better than a long narrow structure. (11) Building on a hillside may permit fruit to be unloaded and packed on the second floor. Packed fruit may then be stored on the first floor and hauled out from the lower side of the building, and all fruit can be lowered to the basement by chutes or reverse elevators where it can accumulate without interfering with operations about the packing-table.

Handling the western box apple crop

The packing-house, whether it be a rude shelter or an elaborately equipped plant, is a recognized necessity in handling the boxed apple crop. More exact grading and sorting are required for boxed apples and this labor may be performed best in the centralized packing-house to which the fruit is drawn from the orchard. As stated above, common storage space is very often combined with the packing-shed, particularly in the case of the community packing-house. In such instances, the packing-house serves a double purpose. It provides space not only for the necessary packing-house equipment, but also for storing a large portion of either the loose or packed fruit. It is generally estimated that the packing-house should have storage for about one-third of its total output. In regions where car shortage is likely to occur, this is a good form of insurance.

There is a most decided drift to the community packing

system in most western districts and under this plan, large expensive packing-houses are practicable. The individual grower, however, commonly uses a lean-to shed or small frame apple house frequently constructed with a concrete basement. Enough space is usually provided in the packing-house for storing a considerable quantity of loose fruit which may be packed out in inclement weather.

Orchard carriers.

In the boxed apple regions, the orchardist usually distributes loose boxes under the trees throughout the orchard so that the picker is not obliged to carry the fruit away from the base of the tree. Lug boxes, made of heavier lumber and slightly larger than the ordinary apple box, have met with some favor as orchard carriers. As a matter of economy, however, the western grower ordinarily prefers to use the standard northwest box as an orchard carrier, later using the same box as a package for the graded fruit.

Low-wheeled orchard wagons are employed in hauling the loose boxes to the packing-shed.

Sorting and packing the boxed apples.

The operation of sorting is logically divided into sizing and grading for color, quality and freedom from blemishes. As has been stated, the barrel apple crop has thus far largely been packed out according to grades based on size, although in some regions distinction is made between the first and second grade according to color and quality, and freedom from blemishes.

In the West, three standard grades are recognized and

are commonly spoken of as: (1) Extra Fancy, (2) Fancy, and (3) C grade. Grading rules governing these three grades vary slightly from year to year. In a general way, however, only normal apples approaching physical perfection are specified as falling within the Extra Fancy grade. Greater tolerance in the way of color requirements and blemishes is permitted in the Fancy grade, although the fruit must be perfectly sound and of a high marketable quality. The "C" grade permits poorly colored or slightly misshapen fruit which is still sound. In the Pacific Northwest, all three grades are wrapped with paper, the diagonal pack being used.

It is customary to hire sorters by the day while packing is by the piece. In the inter-mountain regions including the states of Colorado, New Mexico, and Utah, all grades are not wrapped. In these states, a jumble or face and fill pack is common except in the case of Extra Fancy apples.

It is interesting to know that in the movement for standardization of grades and packs, less attention is being given to grading by size and more according to quality and physical perfection. This is particularly applicable to the Northwest where the size of apples is clearly indicated by the number stamped on the outside of the box.

The mechanical sizer, although growing in popularity and more widely used in the West than elsewhere, is not universal among all box apple-growers. It is generally felt that a mechanical sizer is only practicable when the crop amounts to 10,000 boxes or more. Many western growers still prefer to sort out their fruit from canvas or burlap-top tables similar to those used in the East and Middle West. Still others sort directly from the picking boxes as they are drawn to the packing-house. When hand

sorting is practiced, the sorters usually grade out the fruit into three grades without regard to size, the sizing being done by the packers. A long table with the sorters on one side and the packers on the other has been found efficient by many western growers. Others not infrequently size and grade by hand from canvas conveyer belts.

Packing-house arrangement and operation.

As might be expected, efficiency is exceedingly important in western packing-houses, where the system of grading and handling is very intricate. In the larger packing-houses of the West, conveyer belts and gravity conveyers are commonly used in receiving the fruit from the wagon and for moving the boxes about the warehouse or into the car.

Gravity or belt conveyers eliminate much irksome labor in lifting boxes. In the modern packing-houses of the West, the boxes of loose fruit are unloaded from the wagon upon conveyers and are quickly carried to any part of the house desired. In moving the boxes about within the house, conveyers are used in bringing the loose fruit to the sizer and afterwards in carrying the packed boxes to the car or into storage. In the smaller houses, waiters are usually employed in carrying the fruit about the packing-house in order that the sorters and packers may continue their work uninterrupted.

When mechanical sizers are used, much the same system of operation is followed as has been outlined for the packing-house with mechanical sizers under eastern conditions, but it must be remembered, however, that many more sizes are packed out in the case of boxed apples than with the barrel pack. For this reason, a more elaborate system of

bins and a more accurate sizing machine is necessary. In most of the larger packing-sheds of the West, the main floor is used for receiving the fruit and as the packing-room.

The system of handling the loose fruit as it comes in from the orchard is important. A receiving platform on the north side of the house is convenient for storing the fruit which is to be packed out immediately. Additional storing space for the loose boxes should be provided on the packing floor. All congestion tends to inefficiency. Increased needs should be anticipated.

An example of efficiency is seen in the large packing-shed which is equipped with conveyer belts carrying the loose boxes from the wagon directly to the sizing machine. Sorters examine the apples and then pass them to the sizing mechanism, and packers stationed at the bins immediately pack the fruit. Carriers or conveyors bring empty boxes to the packers and carry the packed boxes to the nailer. The packed fruit is then nailed, stamped and carried by conveyors either into storage or into the car for shipment. The movement of fruit to the car is delayed only by temporary storage as it is being fed into the sizer. As emphasized before, it is important that the fruit continue in one direction when passing through the packing-house. Careful attention should be given to the disposition of culls which are likely to cause congestion if left to accumulate on the packing floor. Removing the culls to elevated bins by conveying belts or allowing them to pass by means of canvas chutes into the basement are two means of solving this problem. The increasing value of cull fruit makes it advisable that this part of the crop be handled with great care to prevent unnecessary bruising.

1

2

3

4

Plate XIX.— Packing the fruit. 1. Well packed boxes of apples showing different styles of packing used on large and small fruit. 2. Good example of ring tailing. 3. An excellent face made with $2\frac{3}{4}$-inch apples. 4. Trucks have largely supplanted this method of hauling packed boxes in the Wenatchee Valley.

Mechanical sizer (Plate XX)

The sizing machine has become such an important factor in the handling of both the commercial barreled and boxed apple crop as to require separate treatment. It seems apparent that this labor-saving device is destined to play an increasingly important part in the handling of commercial apples. The chief criticism offered against it is the attending danger of careless handling, which is being rapidly eliminated by greater mechanical perfection and judicious operation. One of the greatest advantages of the mechanical grader is sometimes overlooked. It lies in the precision with which the fruit may be handled. A machine properly fed insures a steady flow of fruit through the packing-house. Shirking, wasted or lost time becomes apparent at any delay.

There are two general types in mechanical sizers: Those which size by weight and those which size by measurement. The former type seems best adapted to the use of the western growers, owing to the fact that boxed apples must be closely sized. Machines of the second type are more commonly used throughout the East where extreme accuracy is not required. Sizing machines vary in size, capacity, and price. The grower should insist on thorough demonstration. Electricity is the most satisfactory motive power in operating the larger machines, although gasoline engines and even hand power are very often employed with the smaller types.

The following points should be considered when purchasing a sizing machine: (1) The capacity of the sizer should be consistent with the amount of fruit to be handled. (2) Simplicity of design should be sought as well as dur-

ability. Extreme accuracy is not required in sizing barreled apples as is the case with boxed apples. (3) The sizing should be accomplished without bruising the fruit.

Community packing-houses

The community packing-house idea is gaining in popularity and prominence, being a development of the coöperative movement so important among fruit-growers. The advantages of community packing-houses are numerous, and yet this plan is feasible only under certain favorable conditions. At the present time, most of the community packing-houses are in the western apple regions. By far the larger portion of the crop in such districts as Wenatchee is being packed out under the community plan. This practice is gaining in western New York and in many other regions, and promises to play an increasingly important part in the efficient handling of the barrel apple crop.

Some of the necessary conditions for the successful operation of community packing-houses are as follows: (1) The plan is feasible only where more or less intensive and centralized plantings occur. While instances have been cited when fruit has been successfully hauled twenty miles to a communuity packing-house, it seems highly important that sufficient fruit be obtained within a radius of about four miles. Twelve miles, over good roads, is given as the maximum haul in the Pacific Northwest. (2) One hundred cars is usually considered the minimum which can be handled through a community packing-house with the greatest economy. (3) Community packing-houses should, scarcely without exception, be situated on a railroad. (4) There must be a community spirit and

willingness to coöperate among growers. (5) There must be some uniformity in the character of the fruit handled in order that there may be a common interest among growers.

The following are some of the advantages in the community packing-house plan: (1) There is a possibility of a greater standardization of grades. Apples packed up under a single management will be more uniform in grade than if packed under the direction of a dozen or more individuals. (2) Competent help may be attracted by longer periods of employment. (3) By combining capital it becomes possible for the growers to build modern packing plants and equip them with all the labor-saving devices without incurring too great overhead expense. (4) It becomes economical to provide storage space as an insurance against loss. (5) A saving of 3 to 5 cents a box and 10 to 15 cents a barrel is ordinarily effected in handling the crop, particularly if supplies are purchased in quantities for the members. (6) Community trucks may be employed economically in hauling fruit to the packing-house. (7) The grower may give his entire attention to the packing operation instead of devoting his efforts to finding a packing crew.

Methods of operating community packing-houses.

In most instances the grower hauls his fruit in loose boxes or barrels to the community shed where it retains the grower's identity during the packing operation. The cost of packing is pro rated by the barrel or box among the contributing members. Sufficient fruit must be handled to warrant the employment of a competent manager.

An interesting plan has been evolved and is being operated successfully in certain parts of the West. Under this method the grower's fruit loses its identity, first being weighed and credit being given for a certain amount of fruit by weight. A sample is taken representing 3 to 5 per cent of each load and unbiased inspectors grade out the sample to determine what percentage will fall within the different grades. In this way, the grower of high-grade fruit is protected and credited for his superior product. The two principal advantages of this plan are that it saves about one-third of the storage space in the packing-house since each grower's fruit does not have to be packed by itself, and the growers know immediately into what grades their fruit will pack out. The chief disadvantages are that much depends on the sample and the fruit may not pack out according to tests which causes dissatisfaction among members. The tendency is to examine fruit too critically.

Packing-house construction.

Common storage plays such an important part in the handling of the boxed apple crop that it should receive separate, although necessarily brief, consideration in this discussion. Very often and particularly under the community plan, the packing-house serves also as a common storage. It is a common practice in the Northwest to pack the fruit on the main floor and store in the basement. Occasionally only a portion of the building is insulated, the remainder being used solely for the packing operations. In some instances, the packing-house is entirely separate but adjoining a common storage.

In any event, it should be remembered that a room can-

not serve as a common storage and at the same time be used for packing operations. Particularly is this true in the early fall when the day temperatures are high. At this time of the year, all doors and openings should be kept tightly closed during the day. It is even suggested that the doors be opened to admit fruit only in the early morning. It is still better to open no doors but admit the boxes through a small opening fitted with canvas flap, as can be done if conveyers are used.

The hollow tile construction once so popular in the Northwest is not entirely successful without other insulators. In laying such tile, it is impossible to make all joints perfect and for this reason the dead air space is lost. Cork is the most effective insulator but it is very expensive. Eight inches of mill shavings used either in frame or hollow tile construction is the most economical and at the same time efficient insulator for the West. The hollow tile has the advantage of being fire-proof.

Common storage has not been successful with fall varieties such as the Jonathan, since their ripening period occurs before nature's cooling temperatures are obtained. Such varieties should be shipped immediately or placed in cold storage. The Delicious deteriorates and the Spitzenburg tends to shrivel in common storage. On the other hand, the Stayman, if stored unpacked, sometimes keeps better in common than in cold storage on account of its tendency to scald in the latter. A well constructed common storage, if properly operated, can be safely used in the Pacific Northwest for holding most late varieties until February and some into March.

The following are some of the points to be kept in mind when holding or operating a common storage: (1)

The intake area should represent 1 per cent of the floor space and the intake should occur below the false floor. (2) Boxes may be piled six high if two or three feet air space is left between the topmost box and the ceiling. (3) Mill shavings tend to become wet and to rot out when used in basement constructions. (4) Basement storage has the advantage of being cheaper usually and more economical of ground since the packing-room is overhead. At the same time, as stated above, mill shavings tend to rot out and there is the extra labor in lifting fruit when it is to be taken out of storage. (5) Eight inches of mill shavings with one inch air space on either side is generally recommended for the Pacific Northwest. (6) Since the success of common storage depends largely on ventilation, attention must be given to the installation of false floors and proper air intakes and outlets.

Bulk shipments

In discussing the handling of the apple crop, no reference has been made to bulk shipment. In the Middle West, particularly in the Ozark and in the Missouri regions, bulk shipments sometimes represent over one-half of the crop. Ben Davis and Grimes lend themselves to this method of handling. Bulk shipments are important from Colorado and New Mexico.

In bulk handling, the apples are loaded loose into cars previously bedded with straw. It should be remembered that these apples are strictly commercial and enter into competition with barreled stock. As might be expected, there is little uniformity in the quality of the fruit marketed in this way. There is an urgent need for standardization along such lines.

CHAPTER XV

MARKETING AND STORAGE

Both distribution and marketing are of prime importance in the commercial apple industry. It is not sufficient that the apple-grower shall spray, prune and cultivate his trees so that they will produce high-class fruit, but he must familiarize himself with the best systems of marketing in order that his crop may be disposed of in the most satisfactory manner.

Much has been said of the coöperative marketing system for fruits. Little has been done in developing this system, however, in the apple regions outside of the Pacific Northwest. The eastern and middle western growers handle their production largely by consignment, through brokers, or sell directly to cash buyers. The apple-grower employs three common methods in disposing of his crop: (1) selling on consignment; (2) selling packed or graded fruit to cash buyers, or selling the entire crop in the orchard to "lump" buyers; (3) selling under a coöperative system.

SELLING ON CONSIGNMENT

Many growers have practiced consignment with entire satisfaction, although this method of marketing has been the subject of some criticism. The personal element is the determining factor. There are commission firms of the highest integrity whose services and expert knowledge

of marketing can be made invaluable to the producer. A grower should carefully investigate the standing of the firm with which he proposes to deal.

Cash sales are desirable but in years of heavy production and for the grower with miscellaneous and odd lot shipments, consignment is sometimes the only alternative. Not infrequently growers have established relations with certain commission merchants and employ these same firms year after year.

SELLING TO CASH BUYERS

At present the cash buyer is the dominant figure in the marketing of the commercial apple crop. The legitimate cash buyer performs a necessary service in the distribution of the commercial crop. He buys for an established trade and requires only a limited margin to insure a fair profit. In most instances he is an experienced salesman, always seeking to develop and open new markets. The cash buyer is a figure of growing importance in the apple industry.

Much has been said with reference to the popular demand "direct to the consumer." The fact remains, however, that the middle-man performs an important service in the distribution of any crop. It must be remembered, furthermore, that even the present coöperative selling organizations sell largely through brokers or to cash buyers on the market but operate in such circumstances as to secure more consideration than individuals can command. Buyers must have profits commensurate with the risk and sufficient to cover their overhead, and if they lose in one operation they quite naturally must receive sufficient profit to make up for such losses.

The best and most satisfactory system for dealing with

the cash buyer is to sell a certain grade of a variety at a cash price, f. o. b. the car. The importance of contracts should be emphasized even in cash sales. Verbal contracts permit much misconstruction and misunderstanding. It is always important that definite specifications should be drawn up as to the grade and variety of the fruit, time of delivery and method of inspection. Much can be gained by a thorough understanding between the buyer and the seller. Contracts are particularly indispensable when business operations are conducted at long range.

The lump-sum cash buyer.

Under this head is described the system of selling the entire crop on the trees to a buyer who packs and grades out the fruit, assuming entire risk in handling the crop. In general such a system of marketing is very unsatisfactory. It is obvious that the buyer's risk is necessarily great and that he therefore must necessarily have a large margin of profit. There is probably no other region in which this system of marketing fruit is so widely practiced as in the Watsonville district or the Pajaro Valley of California. Lump-sum buying strikes a blow at the community spirit by checking the development of a high standard for the output of a region.

Tree-run cash buyer.

Throughout certain regions and particularly in western New York, the tree-run buyer plays an important part in the marketing of the apple crop. Under this system the cash buyer offers a certain price a barrel for the grower's entire crop, culls and cider stock sometimes excluded. The buyer then grades and packs out the fruit. Growers

of rather low-grade fruit are attracted to this system of selling. However, the tree-run system of handling fruit does not encourage the highest cultural methods and tends to lower the grade of fruit produced. It should be discouraged.

COÖPERATIVE METHODS OF SELLING

Coöperative handling and marketing has been most widely attempted in the western states, both in the distribution of citrus and deciduous fruits. Confronted with the problems of rapidly increasing production, extreme distance from market and high land values, the western fruit-grower has realized the precariousness of highly specialized farming and has felt the need of organization and coöperation more keenly than the eastern growers. Heavy investment has made it impossible for him to turn to other types of farming, and it has been in periods of desperation when prices failed to meet the cost of production that most comprehensive coöperative movements have been inaugurated. It should not be understood that failure has constantly followed in the foot-steps of the western fruit-grower, for years of good prices and large yields have brought excellent returns. The western grower in many instances has devoted his entire capital to the production of fruit. Naturally he resorts to every means within his power to stabilize and organize the industry on a profitable basis. When a period of low prices prevails in the East or Middle West, the growers of these regions having more diversified farms give less attention to the growing and marketing of their apple crop and more attention to their other enterprizes.

One of the largest coöperative fruit marketing organiza-

tions in the United States, known as the California Fruit Growers' Exchange, was organized in 1905 for the purpose of solving the complex marketing and distributing problems confronting the citrus-growers of southern California. A similar organization exists among the Florida citrus-growers and at present among the Georgia peach-growers. Each of these organizations controls more than half of the fruit production of its respective region.

It must not be understood that the apple industry is exactly analogous with either the citrus or peach industry. The citrus region of southern California is extremely compact; the same is true of the Florida citrus district. These two sections embrace comparatively few counties, yet represent in production nearly the entire citrus crop of the United States. The Georgia peaches are among the first to reach the market and competition is limited largely by the production from Texas, Oklahoma and Arkansas. The apple crop which comes on the market at about the same time from many regions represents a different problem.

Coöperative handling of apples has played a very important part in the industry of the western irrigated sections, notably in the Grand Valley of Colorado, in the Yakima, Wenatchee and Spokane valleys of Washington; in the Hood River Valley of Oregon and in certain districts of Idaho. It has been difficult to follow the growth and development of each of the many coöperative organizations in the Northwest. Some have persisted and enlarged their scope, while others have been abandoned. Many more have failed than have succeeded. Very few of the coöperative marketing organizations which were operative a few years ago are in existence to-day. There is always

the inherent individualism of farmers as a class to be considered and also their strong inclination toward independent operation of their own business affairs.

There can be little argument advanced against coöperation among fruit-growers, the question being as to just how far this coöperation will extend and what form it will assume. The following are some of the necessary elements for successful coöperative marketing:

(1) There must be a community spirit in the region which will prompt growers to act coöperatively.

(2) There must be more or less compactness and concentration of planting. Growers operating scattering orchards at a considerable distance from one another can seldom be brought together under a coöperative plan. There must be a sufficient quantity of fruit produced within a more or less limited region in order that the crop may be handled economically under coöperation. Many coöperative organizations have failed on account of excessive overhead expense.

(3) A desirable membership must be secured. One danger with newly organized associations is that in their eagerness for new members they are likely to acquire a quantity of undesirable fruit which must be handled by the association. Rather than lose members and political prestige, the management very often fails to enforce grading rules and thereby permits the low-grade fruit to determine the selling price.

In trying to bring too many growers under one association, the organizers lose sight of the fact that only a small percentage of the apple crop of the United States is produced in any one state or region. The advantage of controlling a large percentage of the tonnage in any one

district is not to be questioned, but too great importance should not be attached to large memberships, particularly if they are indiscriminately selected. From a practical standpoint, the best organizations are those which have grown gradually in membership and which have been careful to exclude the grower of poor fruit. By having only the cream of the output of any particular region, the best returns are obtained for the growers.

(4) Distance from market is another important factor which must be considered for successful coöperation. An apple-grower situated close to market who has exceptionally high quality fruit, for which he has built up a special market, will be less inclined to abandon his special trade for membership in an association. On the other hand, growers in more remote regions have favored coöperation since it sets up machinery to relieve them of the entire problem of marketing their own fruit for which they have neither the experience nor training. In addition, it enables them to have personal representatives in distant markets.

Form of organization for coöperative associations.

There are two general forms for organizing coöperative associations: (1) stock corporation; (2) non-stock system. Of these the non-stock system is the better. Rather than sell stock and maintain a private corporation which may drift into the hands of a few of the largest stockholders, it is better that each contributing member should cast a single vote in a purely non-profit or coöperative society. The voting power under this system might be made to vary according to the amount of fruit shipped, but as a rule the one vote a member system is most satisfactory

and equitable. In emphasizing the advantage of the nonstock system, it should be stated that such organizations enjoy special benefits under legislation fostering coöperative effort among farmers. The activities of private stock corporations may be curtailed by legislation designed to prevent operations in restraint of trade.

Good business management is one of the prime prerequisites for the establishment of a successful coöperative organization. It is obvious that a sufficiently large tonnage of fruit must be handled to warrant the employment of an experienced and competent manager. The board of directors should exercise supervisory powers and should be thoroughly in touch with the business operation of the organization. Too often association managers have been selected on account of their political activity rather than for their training and experience in marketing fruit. It is highly important that this manager should have ability as a salesman; otherwise the advantages of coöperative selling may be lost.

Good business practices should be employed. A proper accounting and auditing system should be installed and those handling the funds should be bonded. It should be possible for the directorate and management to know the exact condition of the business at all times.

If a coöperative organization is to enjoy stability, its members must be bound under a specified contract to sell their fruit through the association. One-year contracts are usually satisfactory, although they may be made for a longer term. On joining the association, each member should be required to sign a contract whereby he agrees to sell his fruit through the association. This contract must

be legally binding. It is obvious that no well-organized selling system can be developed unless the management knows approximately the amount of tonnage which it will be called on to handle.

Pooling.

The practice of pooling the fruit of different members of an association and selling it under one brand has developed widely in the West. Uniformity in the quality of the fruit in each pool is an absolute necessity to the successful operation of such a system; otherwise the poor fruit will bring down the price of the good and result in dissatisfaction among members. In other words, the most successful pools can only be brought about when the fruit of the contributing members has been grown with similar cultural methods and under similar climatic and soil conditions.

The only criticism which may be brought against pooling is that it may penalize the grower of exceptionally fine fruit. This may be avoided, however, if careful grading rules are adopted and unbiased inspection is enforced. Under a successfully operated pool, the grade of all fruit may be raised rather than lowered, thus insuring the highest market price. Another distinct advantage under the pooling system is in the protection which it affords an individual grower against the sudden rise or fall in prices. One shipment of fruit may be damaged in shipment, or may be sold at a figure lower than later market prices. This loss distributed over a large membership would not be felt, but with an individual it might be disastrous. All fruit cannot be placed on the market at the same time

and in effecting successful distribution the association may employ the pooling system very satisfactorily in securing an average high price for its fruit.

The central packing-house which is playing so important a part in the coöperative handling and pooling of fruit has been given separate treatment in Chapter XIV.

Purchase of supplies.

A most direct benefit to be derived from coöperative organizations, and one which appeals very strongly to growers, is the purchase of necessary supplies in large quantities at low prices. This factor very often proves the tie that holds the membership together in the face of adversity, since it offers a concrete example of the advantage of dealing in quantities. Spray materials, boxes or barrels, and all supplies necessary in the production and marketing of apples, can very often be purchased in quantity by the association at a great saving to its members. In many instances these materials are advanced to the grower in the form of credit, his crop having previously been signed up with the association as security for such advances. A double saving may result from the ability of the association to buy materials on a cash basis and extend credit to its members, by using their combined security as a basis for lower interest rates on borrowed capital than the individual might be obliged to pay.

DISTRIBUTION

Better distribution is the keynote in all successful marketing efforts. The methods by which the grower gets his fruit into commercial channels have already been discussed. In studying the machinery of distribution, there

are four fairly well defined factors: (1) The commission-man; (2) the broker; (3) the carlot operator; (4) the carlot distributor.

Commission-man.

The commission-man is usually allowed 5 to 10 per cent of the gross sales for his services. His incentive for making satisfactory returns is his desire for retaining the business of his patron. As emphasized elsewhere, the success of this system of marketing depends entirely on the personal element. It is obvious that the commission merchant must know in advance of the quantity of goods he will be called on to handle. Therefore, if this method is employed, arrangements should be made as far in advance as possible.

The broker.

The legitimate apple broker is one of the important factors in the distribution of the commercial crop. His function is to negotiate sales between dealers or between growers and dealers. The commission-man handles the consignment, keeps all accounts and deducts his commission. The broker does not handle the funds, but receives a stipulated commission, say $10 to $15 a car for his services.

Theoretically, the broker represents both the seller and buyer. He is supposed to advise the seller as to general marketing conditions, or in other words take the place of a personal representative in the market. He is supposed also to help in making equitable settlement in case of disputes between contracting parties. The personal equation enters very largely into this situation. The grower would

do well to inform himself as to the integrity of the firm with which he proposes to deal, and by establishing relations with reliable firms be able to insure best results.

The usual method of procedure in dealing with the broker is as follows: The seller having a carload of a certain grade of a variety will advise his broker of the fact and of the price which he desires. The broker will undertake to place the car and if successful will communicate with the seller, instructing him to forward the fruit. This method of handling really amounts to an f. o. b. sale, permission being given by the grower for inspection at destination. In case of a misunderstanding over grades, the broker is in a position to effect equitable settlement. The grower bills his fruit to the broker or to the buyer, attaching a sight draft to the bill of lading which is sent to a bank designated by the buyer. After inspection on arrival, the buyer lifts the draft through his banker, thereby effecting a direct settlement with the seller.

Carlot operator.

The carlot operator plays an important part in the distribution of the commercial apple crop. He is usually represented in important regions of production by cash buyers, who contract fruit on his account. The carlot operator may sell again in carload lots, may place the fruit in storage on his own account or may distribute it to the jobber or retailer. The amount of business handled by carlot operators may vary from a very few cars to several hundred or even thousands, depending somewhat on the field for distribution. The carlot operator for a city with a more or less limited field may be able to distribute successfully only a few cars. A large operator with head-

quarters in New York City may distribute his purchases all over the world. The carlot operator usually has a certain trade built up in a given region and buys to supply this trade. His business resembles that of a wholesale groceryman who carefully gauges the demands of his customers and buys to fill their needs.

Carlot distributors.

In recent years, various forms of distributing agencies have been established for the purpose of accomplishing in a measure for the whole country what a broker or commission merchant does for his immediate city or vicinity. By handling a large volume of business, such agencies are enabled to build up a competent sales organization at a fairly low overhead. Coöperative marketing associations or individual growers frequently employ such selling agencies usually on a flat fee, a package or occasionally on a percentage basis. For an additional charge the sales agency sometimes does the necessary warehousing.

This type of sales service has many advantages. While growers or growers' organizations are usually obliged to sign up their crop in advance of the season, they are given the privilege of confirming or rejecting orders as secured by the selling agency. Not infrequently carlot distributors help finance the crop by making advances to individual growers during the growing season.

FIELD OF DISTRIBUTION

Foreign markets.

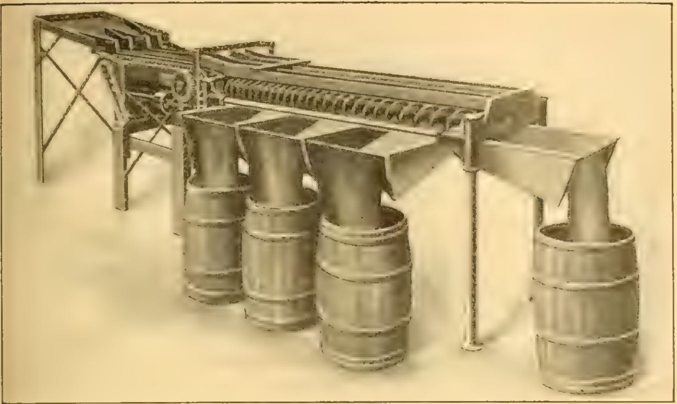
The extension and development of foreign markets is a popular subject for consideration. The extent to which this trade may be developed is of course largely a matter

of conjecture. If the high quality apple approaches a luxury for many persons of this country, it indeed represents a luxury for most foreign consumers. When transportation, duty, insurance, interior freight and duty are added to the original cost, the American apple can appeal only to the well-to-do. Despite this, exportations to foreign markets in some years have approximated 10 per cent of the total commercial apple crop of this country. While the amount of export trade varies considerably with the size of the crop and with general marketing conditions, a study of the figures indicates a very considerable normal increase in exportation of fresh apples in the past ten years.

The United Kingdom has always been the principal export market, absorbing normally over 80 per cent of all export trade. Australia and even oriental markets have been studied more recently with the view to effecting wider distribution of the apple crop. These latter markets are as yet of little importance in comparison with the heavy European demand.

Business relations at long range are sometimes unsatisfactory. But if this difficulty may be overcome, export fields are promising. If this country, with its abundance of fresh food stuffs, can absorb over twenty million barrels of commercial apples annually, it seems reasonable that foreign trade, particularly with thickly populated European countries, will afford an excellent outlet for at least 10 per cent or more of the total production. Such an outlet will always relieve the strain on local markets and will act as a safety valve for the excess supplies which might otherwise glut domestic trade.

Barreled and boxed apples were in general about equally



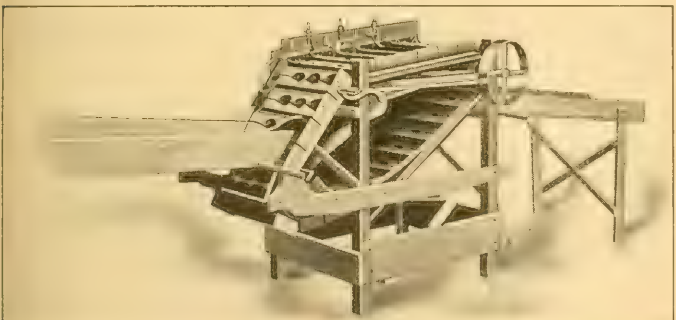


PLATE XX.— Sizing and grading machines. *Upper.* Sizing machine with diverging spiral rollers. *Middle.* This machine sizes the fruit through cups which enlarge as the belt moves along. *Lower.* Grading machine equipped with sizing belts made of linked rings. A common type used in many sections.

represented in the export trade of the United States for 1919. Of the barreled apples, the Baldwin and Northern Spy from New York and New England, York Imperial and Ben Davis from the Shenandoah-Cumberland region and Yellow Newtown or Albemarle Pippin from the Piedmont of Virginia, have been the leading export varieties. Of the western boxed apples, Yellow Newtown, Winesap, Jonathan, Esopus and White Pearmain have been the most prominent varieties for export.

Improved distribution within the United States.

The greatest opportunity in the field of distribution is in the extension and development of domestic trade. Attention has been called to the fact that the home orchards generally throughout the United States have been dying out and that the commercial industry is being centralized in a few favored regions. The line of distinction between commercial and non-commercial production is being more closely drawn. The consumers are demanding a higher class product and on being furnished with this are increasing their demand.

Not many years ago before the installation of general cold storage facilities, the trade in small towns and even the larger cities was supplied from the cellar of the general farmer who grew a few more apples in his home orchard than he had need for. These orchards in most instances have been going backward; the trees are unsprayed, the fruit is inferior in quality and unattractive. Consumers are coming to demand a better product. It is in supplying the demand in these smaller towns and cities that the commercial apple-grower will find the greatest opportunity for better distribution.

The secret of success in the distribution of the California orange crop has been its sale in every cross-road village in the country. The production and sale of oranges in recent years has increased much more rapidly than has population. By organized effort, wider distribution into the smaller markets, the orange-growers have been marketing a constantly increasing production. The same may be accomplished by the apple-growers and shippers if they will employ similar methods of advertisement and distribution.

Whether the growers market their apples coöperatively, through private brokers or by private sales service, there must be campaigns of education and advertisement in order to effect distribution. The futility of trying to work out broad comprehensive plans for distribution when each grower or shipper acts independently is evident. Such plans lend themselves best to coöperative effort. The burden of expense incident to the working out of better plans of distribution must be widely distributed in order that it will not fall too heavily on any one individual.

The question of advertisement presents an interesting field. Notable examples of the establishment of brands of commercial grades are seen in the efforts of different associations in the Pacific Northwest. By assessing each box sold under a given brand with a small charge for advertisement, large sums are secured to carry out advertising campaigns. By limiting the varieties sold under a given brand to those of high dessert quality, by including only the highly desirable sizes and zealously enforcing grading rules, shippers can develop a brand of superb marketable quality. Whether such a system can be recommended for general adoption remains to be seen. Such

advertisement has gone far in effecting better distribution for the northwestern boxed apples.

Physical handling.

The same attention should be given to better physical handling of apples as to better cultural methods. A grower can not afford to devote his best energies in producing high quality apples only to subject them to the abuse of improper physical handling. The importance of careful orchard practices with reference to picking and packing and immediate storage have been emphasized. In addition the apples must be transported in cars, must be handled in and out of storage and in all of these operations much can be done to improve present methods. The development of new types of refrigerator cars, improved methods of car loading and ventilation are of vital importance to the apple-growers and shippers.

GRADES AND STANDARDS

The movement for uniform grades and standards should be considered by every apple-grower. Probably no other phase of the marketing problem is receiving greater attention at this time than that of standard grade and pack. Certainly no other movement can do more in stabilizing the apple industry.

It is generally agreed that the standardization of grade and pack is a governmental function. There is, however, a variance of opinion as to methods of enforcement. State and federal legislation has been formulated with the view towards promulgating certain definite rules which shall specify the character of fruit to be sold under established

standard grades. These rules are intended to act as a standard of measure, whereby the buyer may judge the character and the contents of the closed package of apples. In other words, the label on the package of apples is to be made to tell the truth. The difficulties of promulgating a set of rules which will please every one or even a majority is at the outset a difficult problem. Furthermore, once promulgated it is exceedingly difficult to secure the enforcement of such a set of rules.

Standard package.

Obviously the first step in standardization is the establishment of uniform packages. This has already been effected to a great extent by the adoption of the dual standard, i. e. the standard barrel and the standard box. Persons are accustomed to think of commercial apples in terms of barrels and boxes. In a geographic way, line of distinction between barrel apple-producing areas and box apple-producing areas has been closely drawn. For Colorado and states west, the box is the almost exclusive package, while for the eastern and middle western apple crop the barrel is almost exclusively used.

From time to time different packages have been introduced, but their popularity has been more or less temporary. Various crates have been recommended for western low-grade apples and in certain seasons a considerable portion of the New York crop has moved out in bushel baskets. The five-eighths-bushel hamper is very popular in the early apple regions of New Jersey and Delaware. In many ways the smaller package enjoys a distinct advantage, and while the barrel will probably remain the standard package for eastern and middle western apples, it is

not improbable that the growers will find it advisable to market a part of their crop in smaller packages in order to attract the smaller purchaser.

The bulk handling of apples should receive separate consideration. In normal years, at least half of the production of the Ozark and the Missouri River region is sold in bulk. Recently bulk handling has featured in the movement of the apple crop from Colorado and New Mexico. Middle western growers maintain that the bulk handling of a certain grade of apples is an efficient system since it enables them to sell a portion of their crop to a class of trade which would otherwise be unable to buy commercial apples. The middle western grower further maintains that after carefully bedding a car with straw, he is able to load apples in bulk without severe bruising. It must be remembered that this bulk movement from the West is essentially competitive with the barreled crop.

Many state laws have been enacted looking towards the establishment of uniform grades and standards for commercial apples. For the most part, these laws are inactive on account of lack of funds for their enforcement. Washington has devoted as much effort along these lines as probably any other state, unless it is New York. The Washington grading laws provide for an annual meeting of apple-growers, at which time uniform grade specifications are adopted for the ensuing year. In other words, no hard and fast rules are laid down for a period of years and the specifications are subject to change each year at the majority will of the growers. Obviously, a law which would be applicable for all states, and furthermore which could be enforced, would have to be rather general. Such a law, however, would tend to keep poorly graded fruit

out of commercial channels and would, therefore, work to the benefit of the strictly commercial growers in the highly intensive regions. It is not criminal to grow low-grade fruit, but such fruit should not be misbranded or should not sell under false colors to the detriment of the producer of high-grade apples.

The question of "facing" the barrel pack is one over which much discussion has arisen. "Facing" refers to the practice of placing select apples on the top layer in order to give a good appearance to the pack. This does not enter into the problem of box standards, since inspection may be made at the top, bottom, or side of the box. While it may be legitimate to arrange the top layer so as to give a neat appearance to the barrel pack, a real standard grading law would surely require the contents of the barrel to be uniform.

The project of establishing uniform grades and standards enlists much active support and at the same time is the subject of much controversy. Generally speaking, every concerted move towards a standardization of grade and pack will work to the benefit of the strictly commercial apple-grower and will serve to make a closer distinction between the commercial and non-commercial crop. For that reason every conscientious effort in working out uniform grades and standards seems meritorious.

Inspection at point of origin.

Many prominent apple-growers are insistent on government inspection at point of origin. A common reason for low returns to the grower has been the poor condition of the fruit at the time of its arrival at market. Furthermore, there are always changes in transport to be reckoned

with. Federal and state governments may be potent factors in controlling evils which exist under the present system of fruit inspection.

Some apple-growers think inspection at point of origin should entirely supplant that at the place of arrival. In other words, it is maintained that all sales should be made f. o. b. and that the purchaser should assume the risk after the apples have been shipped. While inspection at point of origin is unquestionably a highly desirable step and will go far toward better understanding between grower and dealer, it seems hardly probable that the buyer will assume all risk incident to the transportation and delivery of the fruit without a rather large margin commensurate with the risk.

The report of an unbiased government inspector would be of great value to any one interested in the purchase or sale of apples. Such inspection at point of origin and particularly at place of destination would establish the damage, if any in transit, and would do much in effecting satisfactory business dealings. If the shipper could be reliably informed as to the exact condition in which his fruit arrives at destination, it would materially aid in studies affecting proper handling methods.

STORAGE

The storing of apples is intimately associated with problems of marketing and yet it is a subject of such complexity as not to permit of complete treatment without thorough scientific discussion involving the practice of storage-house construction and methods of management. Only brief consideration can be given to storage in this work, however.

The effects of improved storage have been far reaching. It is obvious that a practice which will prolong the marketing period of any seasonal commodity will have a great influence in its distribution. The possibility of storing fruit has also had an important influence on our leading commercial apple varieties. Formerly only a few of the very late keeping sorts were available for distribution during the late winter and early spring months.

Under the present system of handling through storage, it is possible to prolong the life of more delicate and higher quality varieties and in this way greatly stimulate the demand for apples late in the season. The greater part of the commercial apple crop will always be placed in storage for periods of varying length and a general knowledge of the principles involved is of much importance. The difference between common and cold storage is generally understood. The former method depends on natural atmospheric temperatures and the latter on artificial cooling.

Life processes of the apple do not cease at the time of picking and it is important to retard these processes by getting the fruit into storage with as little delay as possible. A day or two of exposure to the warm sun may shorten the life of the fruit very materially. Emphasis has already been placed on the desirability of transferring the fruit from the orchard to the packing-house as quickly after picking as possible.

Local vs. distance storage.

Cold-storage plants were formerly situated near the larger markets. In recent years, however, there has been a growing tendency towards the establishment of cold-

storage plants in the regions of production. Storage at the point of origin has one distinct advantage. By keeping the fruit here the shipper or grower is not committed to any particular market, but may hold his fruit or ship to such market as he may see fit. By holding a portion of the crop in regions of production, the strain on transportation facilities at harvest time is very materially reduced. Storage for at least half the crop, particularly in areas of large production, seems to be recognized as a necessary provision. If the grower or shipper has a well established market, it is advisable for him to store his fruit in or near that market rather than hold it at point of origin. In this way his product is available for quick delivery under favorable marketing conditions in quantities to meet the demand and is not exposed to the dangers incident to traffic.

As stated above, cold-storage plants are for the most part situated in the eastern states. Large plants are located through western New York and provide excellent facilities for handling the barreled crop of this region. Here it is possible for the grower to haul his fruit immediately to the cold storage. At the same time he enjoys the advantage of being in close touch with the eastern marketing conditions.

Common storage.

Common storage has as yet played only a small part in the handling of the eastern apple crop. In the Pacific Northwest, however, this form predominates and is an important factor in the handling of the crop from that region.

No attempt will be made to discuss in detail the relative

merits of different types of common storage construction. The success in managing in the early fall depends on attention given to the opening of vents and doors during the night and closing of them during the day. If the storage-rooms are not kept separate from the packing-rooms, the purpose of the cooling system is largely defeated.

Small storage plants on individual farms or in connection with community organizations are becoming more and more common. By having separate rooms for packing or using the basement only for storage, a combination packing- and storage-house may be constructed economically. The grower may then feel greater sense of security in knowing that he will have several weeks or even months in which to dispose of his fruit. Common storage can never supplant cold-storage and its efficiency will vary somewhat with the season. As an economical and somewhat more temporary method of prolonging the marketing period of commercial apples, it is serving an important need.

Handling and cultural methods as relating to storage.

There is a growing belief that general health and vigor of the trees has a greater influence on the keeping qualities of fruit than has been generally recognized. However, the development of scalds and spots and the deterioration in storage is most frequently traced back to over-maturity or under-maturity or rough handling of the fruit. One advantage in home storage is that the evidences of these troubles may be brought home more forcibly to the grower.

GOVERNMENT AGENCIES IN MARKETING

While the greatest effort in improving marketing conditions has been exerted by the growers and shippers them-

selves, very important steps have been taken in this direction by various agencies in the United States Department of Agriculture, notably the Bureau of Crop Estimates and the Bureau of Markets. Certain phases of the market ing problem, such as inspection, the issuance of crop forecasts and market reports, lend themselves best to governmental agencies. It is impracticable for the individual or even groups of individuals successfully to study all phases of marketing work.

Crop estimates.

The need for reliable crop forecasts is imperative if the grower is to determine the price which he might reasonably expect for his fruit. The perishability of the apple as compared with more stable crops accentuates this need. It is obvious that the government is best fitted to carry on such investigations and can, by the issuance of reliable forecasts, render an important service to the commercial apple-grower.

Market and storage reports.

The second very important service which properly can be rendered by a governmental agency is the issuance of reports showing the distribution of the crop. By comprehensive investigation it is possible for the government to issue reports showing the point of origin and destination of each carload of commercial apples. Shippers and growers alike will be enabled to use this information in seeking out untouched markets. Since the keynote in better marketing is the extension of distribution to small towns and cities, it may be seen that the result of such

investigation will be an invaluable guide to better distribution.

The value of unbiased market reports which will afford the growers and shippers alike the benefit of telegraphic news service as relating to the price and marketing conditions of apples in the different centers is already recognized.

COÖPERATION VS. INDIVIDUAL EFFORT

The government has at all times encouraged and fostered coöperative spirit among growers. Despite this cooperative effort, it must be recognized that by the issuance and dissemination of reliable crop forecasts and reports, and by its market news and inspection service, the government is making the individual more independent and more able to conduct his business than formerly. Just what the effect of these divergent tendencies will be remains to be seen. For the exceptional grower, the man with unusual business acumen, it may mean that he will be enabled to conduct his individual business independently to his greatest satisfaction. On the whole, however, the benefits of coöperation are not to be denied and will doubtless continue to play an increasingly important part in marketing.

CHAPTER XVI

YIELDS

Good yields are absolutely essential to insure profit from any orchard enterprise. The most detailed care may be given to an orchard, but if it is made up of poor yielding varieties or if the soil or climate is not suitable for production, good care is only time and money wasted.

In the first place, it is important to secure good yielding varieties. Most standard varieties of the present day yield fairly well, but many new and untried yet widely advertised sorts are very poor annual bearers. Ben Davis, Baldwin, Winesap, Stayman, Jonathan, York, Rhode Island Greening, and Rome Beauty are old and standard varieties, the high yielding qualities of which are well known. Yellow Newtown and Yellow Bellflower are heavy bearing in certain sections, particularly in the Watsonville district of California. In Virginia the light bearing Yellow Newtown (Albemarle Pippin) and the Arkansas (Black Twig) are not being planted as extensively as the more prolific York Imperial and Stayman. Among earlier varieties, Oldenburg (Duchess), Wealthy, Gravenstein and Maiden Blush are classed as reliable bearers. Yellow Transparent does well in some sections, but yields light crops in other regions. Northern Spy requires a score of years to come into profitable bearing, while the famous Delicious, despite its many excellent qualities, in some sections is only a moderate cropper.

When trees of good yielding varieties are brought to bearing age, careful record should be kept of annual yields, particularly acre yields. One hundred barrels of commercial fruit to the acre is a good average although trees well cared for can often be made to average 200 barrels under normal growing conditions. If an orchard is only averaging from 50 to 100 barrels to the acre (many do not average 50 barrels to the acre), care should be taken to find out the limiting factor. Light yields may be due to a lack of nitrogen or other element in the soil, to lack of pollination, or to poor orchard management. Improper pruning, thinning, spraying or soil management are as often the cause of low yields as the variety of the trees, the season or natural fertility of the soil. Many theories are advanced relative to the development of fruit-buds and fruiting wood, but it is difficult to generalize on this subject.

Good orchard management is for the purpose of securing heavy yields and no study as to the cause of high or low yields would be complete without a consideration of practically every orchard operation. In analyzing the cause of low yields, one should consider first soil fertility. The growing of leguminous cover-crops or the application of such fertilizers as nitrate of soda may be necessary to maintain healthy normal growth of the trees. Thinning will tend to stimulate annual bearing as well as greatly to increase the amount of market quality fruit of any year.

Pruning should be considered in relation to its effect on yields. Many advocate summer pruning for fruit. Under certain conditions it probably stimulates fruit production, but it has not met with wide favor generally. Moderate annual pruning in the dormant season is the

best practice. Thinning and fertilization are much neglected and this accounts for many of the low yielding orchards. Results are not secured by performing one orchard operation thoroughly and neglecting another. Proper pruning, spraying, thinning and an abundance of available plant-food should insure large commercial crops under normal conditions.

In studying yield, one should consider not only the performances of individual trees or orchards in a given region, but more particularly the average yield on well managed orchards typical of the region. Soil fertility and good orchard management do not entirely determine yields. Unfavorable weather at blooming time occurs more frequently in some regions than in others and very often greatly reduces annual yields. There are certain areas, particularly in the more mountainous parts of the country, where on the average one crop out of every four or five is wiped out or severely damaged by hail. It is easy to understand how the profits of good crop years may be almost wiped out by total failures in other years.

In the Wenatchee district of the Northwest, a total fruit crop failure is unknown, while in regions like the Ozarks, the Ohio Valley and the Missouri River region, Michigan and in fact most eastern sections, very light crops and even failures are not infrequent. Most of these failures are due to frost damage, or to unfavorable weather at blooming time which prevents pollination. The frequency of light crops and failures is exceedingly important.

For a period of ten years, the Northwest has had an average of nearly 80 per cent of a full apple crop, while for the same period Missouri, Illinois and the middle western states have had scarcely 50 per cent of an apple

crop. Michigan, New York and New England have shown an average crop condition of about 5 to 10 per cent higher than the Central West, while the crop condition in the Virginias has averaged 10 per cent higher than that of New York. New Jersey and Delaware usually end the season with a condition of about 60 per cent, or 25 per cent less than the Northwest. Thus it is seen that the chances for a good crop are the greatest in the Far West and are next in the middle Atlantic states, third in New York and the northern states, and poorest in the Central West. The low average crop condition in the Central West is largely due to the damp and unfavorable weather which often occurs during blooming time to prevent pollination and a good set of fruit.

The following table refers to western New York conditions and shows the average yield on about fifty commercial orchards in each county over a series of five to eight years. Considerable care was taken in obtaining these figures in order that they might accurately represent the average performance of full bearing commercial orchards in western New York. The table does not include yields from unsprayed or neglected plantings, but represents the production of those orchards which are being cared for. It will be noted that Wayne County shows a larger percentage of cull fruit than any other. This is largely due to the fact that Wayne County is the center of the dried apple industry and much of its fruit which would ordinarily be barreled in other counties is used for drying purposes. The portion of the crop used for by-products varies considerably from year to year.

TABLE XIV

TABLE SHOWING AVERAGE ANNUAL YIELD ON THE BEARING COMMERCIAL ORCHARDS OF WESTERN NEW YORK

Counties.	Barreled Yield.		Cull Yield (Barrels).	
	Per Acre.	Per cent. of total yield.	Per Acre.	Per cent. of total yield.
	Bbl.	%	Bbl.	%
Wayne	73	67	37	33
Ontario	93	79	24	21
Monroe	85	78	24	22
Orleans	87	77	27	23
Niagara	81	79	22	21
All counties	84	76	27	24

The average yield of apples of commercial grade in western New York is 84 barrels to the acre, while in the Wenatchee Valley of Washington it is between 500 and 600 boxes of packed fruit (165 to 200 barrels). The average yield for the Yakima Valley is between 400 and 500 boxes while that for the Hood River Valley is between 250 and 400 boxes to the acre. The average yield in Idaho is between 300 and 400 boxes to the acre. In good crop years, the southern Idaho orchards yield nearly as well as those in the high producing valleys in Washington. However, Idaho's average is reduced on account of occasional crop failures in years of frost-injury. Killing frosts are not uncommon in New Mexico and Utah.

In comparing these yields with those of eastern orchards, it should be remembered that the figures refer only to marketable fruit and do not include culls, the percentage of which is much lower in the Northwest than in most eastern regions where orchards are not given such intensive care. The average yield of 84 barrels to the acre for western New York is more than that throughout the East.

Taking one year with another most of the middle western orchards will not average over 50 barrels to the acre. Michigan orchards bear about as well as those in western New York, while the Hudson Valley and New England trees average somewhat less in annual production. Yields in New Jersey, Pennsylvania and the Shenandoah region compare favorably with those of western New York, while yields in the Piedmont of Virginia will average lighter, due to the greater prevalence of unfavorable weather conditions at blooming time and also to the fact that most of the orchards are mountainous and cultivation is seldom practiced.

One point to be remembered in comparing northwestern yields with those of eastern orchards is that practically all yield records of the Northwest were taken on trees from eight to fifteen years old, while in the East yield records were from trees from twenty to forty years old. On the other hand, there are about twice as many trees to the acre in the Northwest as in western New York and in most all other eastern regions with the exception of Delaware, the Ohio Valley, the Piedmont district of Virginia and Carolina and a few other limited regions where the trees are either of early varieties or have not as yet attained great size. Yields given for the Northwest, although for comparatively young trees, are very nearly a maximum for that region. As trees become older, some will necessarily be pulled out on account of close planting. Furthermore, under northwestern conditions trees attain full bearing at about ten or twelve years.

The possibilities of any section may be determined by searching out the most successful growers and securing a

reliable record of yields in both good and bad years. Certain growers in western New York have harvested 200 to 300 barrels to the acre from their orchards for a series of several years. Such high yielding orchards may be found about Geneva, Brockport and other towns, but their number is very few. In the Wenatchee Valley a few growers obtained as high an average as 1,000 boxes to the acre. Such yields usually occurred on Rome Beauty or Ben Davis orchards, however. The famous Watsonville district of California is another section where annual yields of 1,000 boxes to the acre are not uncommon on the heavy redwood soils of the Pajaro Valley. Orchards which yield fruit in this amount in certain years are found throughout the Middle West, but it is very seldom that average yields approach this figure even in the most carefully cared for orchards.

In studying the yielding possibilities of any orchard, the following points should be considered:

The size of the tree.— Relative size and vigor of the tree for a given age indicates the time required for trees to attain maturity in any given region.

Soil conditions.— The nature of the soil should be noticed, whether or not it is heavy or light, weak or strong, and how well it is adapted to tree growth and fruit production.

The frequency of frost-injury.— Regions are often so situated as to render them very susceptible to frost. Certain areas in nearly all sections are particularly susceptible to frost damage.

Unfavorable conditions at blooming time.— Not only frost but other unfavorable weather conditions often occur.

Cold wet weather which prevents pollination is largely responsible for low yield in certain sections. The history of the region should be carefully noted in this regard.

Total crop failures.— The number of crop failures in the last ten years in any locality should be carefully noted, for it is reasonable to assume that a like number will occur in the next ten years. This consideration is highly important and will also serve to avoid the danger of drawing too favorable conclusions from exceptional performances of orchards in any particular year.

Relative freedom from diseases and insect pests.— The probability of scab or bitter-rot infection should be noted or the presence of any destructive disease or insect which may greatly cut down the crop even after the fruit has set well. Bitter-rot sometimes injures crops in the Virginia Piedmont district. Severe infestations of codlin-moth late in the season often cut the crop in the dry or irrigated western districts. Cedar-rust frequently does heavy damage to the York Imperial crop of the Shenandoah Valley. Apple-blotch often greatly injures the apple crop of the Middle West, while the prevalence of apple-scab renders the market quality of the apple crop of New York and Michigan uncertain. Every region has certain troubles, but it is well to be on the lookout for them and to note the success with which they are being controlled.

The likelihood of hail damage.— Such regions as the Piedmont of Virginia and to a lesser degree the Shenandoah-Cumberland district of Virginia, West Virginia, Maryland and Pennsylvania are often visited by hail. The same is true of the higher altitudes of Colorado and other regions where fruit is grown at considerable altitudes. Hail damage seems to be more prevalent through-

PLATE XXI.— A Baldwin tree near Paonia, Colorado — one of the first trees planted in western Colorado. It bore 60 boxes of packed fruit in 1914. The Baldwin is unimportant commercially in the West.

out the apple regions of the South than in the northern states.

Bearing tendencies of varieties common to the region.— Varieties differ so markedly in bearing tendencies that one should consider this factor before passing judgment on any particular region. Often high quality varieties, even though bearing lighter crops, are fully as profitable as the heavier bearing varieties which are inferior in market quality.

Average annual yield.— It is very important to rely on an average yield and disregard acre or tree performances in any particular year. Only averages of several commercial orchards over a series of at least five years will indicate the relative productivity of different regions. It is best to select the naturally productive sections for it is no more difficult to rise above the average in a high-yielding region than it is in a naturally low-yielding one.

The importance of large yields is further brought out under cost of production. Not only is the gross income increased with larger yields but the cost of production a barrel or box is greatly lowered. The average grower will find his net profits greater if he will practice more intensive methods of culture not counting the initial cost so much as the net results.

CHAPTER XVII

BY-PRODUCTS OF THE APPLE INDUSTRY

THE by-product industry has been of great importance for many years and has assumed added significance since the advent of national prohibition. The apple leads all other fruits in popularity for by-products, the amount used in 1919 exceeding 700,000 tons of green fruit. A large proportion of this was made into vinegar and sweet cider and about 150,000 tons of green fruit were dried, making 25,000 tons of dried fruit. Frequently nearly one-half of the dried fruit is exported as compared to less than one-tenth of the fresh fruit.

The by-product industry, on a commercial scale, has recently assumed large proportions in the Northwest and the Virginias. In former years it reached and still retains its greatest importance in western New York and California. In northwest Arkansas also, the manufacture of apple by-products is an important industry. Dried apples within recent years have been in great demand. The prices have risen several times those of a decade ago. California to-day takes the lead in intensive apple drying. About 10,000 tons were dried in the two counties of Santa Cruz and Sonoma in 1919. This means that the green apples used for this amounted to 60,000 or 70,000 tons or nearly a million barrels.

In the East, Wayne County in western New York has

always been the center of the dried apple industry. Many parts of the country are now taking up the dried apple business and a large proportion of the total apple production is being dried. In California, the Northwest, New York, the Virginias and in Arkansas, the industry is on a large commercial scale. The mountainous parts of the southern states, particularly North Carolina, produce several hundred thousand pounds of dried apples annually. In these states, they are sun-dried on the small mountain farms, the apples being grown almost wholly in old uncared for orchards. The Buckingham apple has long been a favorite in Carolina for drying purposes. Several varieties are used for drying in California but the Yellow Bellflower leads all others. New York dries the Baldwin and Rhode Island Greening.

Nearly all driers of the West are commercial, while in the East the small home driers have long been adhered to. Western New York has several large commercial driers but the great bulk of the Wayne County dried apple production comes from the home driers of which this county contains hundreds.

The by-products industry promises to put apple-growing on a more staple and less speculative basis. Formerly, the grower depended almost wholly on the price a barrel or box of commercial fruit. At present if this price does not warrant putting the apples up in packages or containers, they may be disposed of at by-product plants at a profit. Prohibition has been the important factor determining the 1919 increase in by-product uses and prices. At the present time, about 20 per cent of the apple crop of the United States goes to the by-product plant or is made into cider. In California, almost 50 per cent of the

total crop is dried, while in Wayne County, New York, about 30 per cent is dried. Wenatchee and some of the northwest districts, on account of their ability to produce exceptionally high-grade fruit, send less than 10 per cent to by-product factories. Arkansas, Colorado, many parts of the Middle West, Virginia, Pennsylvania, New Jersey, New York and New England, will, no doubt, increase the percentage of fruit sold for by-products. This will tend to eliminate low-grade fruit from the market. The outlook for the future is bright and the by-product industry has not yet begun to attain full possibilities. It is only within the last three or four years that it has been important or a factor in the apple industry of the Northwest. It rose from a production of almost nothing five years ago to 70,000 tons in 1919 in the state of Washington. Much more detail might be entered into relative to this industry.

EVAPORATORS

In this connection, a full description of all the different types of evaporators cannot be undertaken and but little more than mention can be made of the different designs in use or in course of construction. In general, evaporators may be placed in three classes: natural draft evaporators; forced draft evaporators; and distillation types, including vacuum evaporators.

Natural draft evaporators.

Most of the fruit evaporators in use in New York and other eastern states, in Oregon, Washington, and even in California for the evaporation of apples, are of the natural draft type. The driers of this group require no fan or motor for operation; any type of fuel may be used; they

are simple in construction and operation and not expensive to build or operate. They have survived the test of time extremely well, although it would seem that for Californian conditions at least, they may be replaced by the more modern air blast types. Some of the natural draft evaporators are:

The kiln evaporator is commonly used in California and the East. It is usually constructed in two stories. The upper story houses the drying floor which is usually 20 feet by 20 feet and is made of narrow wooden strips with 1/4 or 3/8 inch spaces left between them to permit passage of hot air. Over the drying floor is a steep four-sided roof which has at its apex a large ventilator for the escape of the spent air. The prepared fruit is placed on the floor and turned by a fork or scoop shovel during drying, a practice which does not add to the appearance or cleanliness of the product. The lower floor contains the heating system. This consists of a wood, coal or oil-burning furnace connected to a number of turns of large heating pipes; usually the whole lower story is almost filled with these pipes, giving a very large radiating surface with consequent efficient utilization of heat. The heated air rises from the pipes through the floor grating and thus over the fruit.

The stack or tower evaporator is the most commonly used at Watsonville, California, where it is successful. The trays of fruit are placed on run-ways in cabinets or "stacks" above a fire-pit; the trays being stacked one above the other. The heated air rises directly through the trays, in this way differing from the tunnel drier. The bottom of each stack or chamber is open, while the top consists of an inverted hopper connecting to the ventilator.

There are many better types of evaporators and its use is not strongly recommended.

Cabinet evaporator is heated by steam coils but otherwise is very similar to the stack evaporator in construction and operation. It has been used recently in New York and Canada for vegetable and apple drying.

Ceramic oven.—The ordinary bake-oven principle has been successfully applied in California. This type of drier should permit of fuel economy as it is constructed throughout of brick and fire brick. There is practically no fire risk and radiation losses should be small.

Electrically heated driers.—Small evaporators for home use have been designed in which an electric current passing through resistance wires furnishes the necessary heat. The drier is of the stack type. Except where electricity is extremely cheap, it is doubtful whether such machines would prove profitable, although a machine of recent design appears to have great possibilities.

Forced draft evaporators.

Most of the new driers on the market belong to this class. The number of different forms is very great and is constantly being added to. Their one common characteristic is the forced air circulation. Outside of this one feature, they are of almost every conceivable design.

Horizontal tunnel.—In general, this type consists of a long chamber or tunnel resting on the ground with an air heating system and fan so arranged that the heated air may be blown or drawn over the trays. Usually the trays are carried on trucks which enter the cooler end of the tunnel and which leave the tunnel from the hotter end. Great variation exists in the methods of heating the air.

The older types used steam pipes, a system which permits exact regulation of the temperature and permits also of "boosting" the temperature of the air as it passes through the tunnel. Those who have used both steam and direct heat, however, prefer the latter because it is claimed to be more economical of fuel. Some heating systems are very similar to those used in the kiln, stack and tunnel types, consisting of a sheet metal furnace attached to radiating pipes, the air being heated by being drawn over the heated metal surfaces. In another form of heater, the air is forced through large pipes held in a fire-box much after the fashion of boiler flues. The most interesting development, however, is the use of the gases of combustion directly in drying, thus doing away with all stack loss of heat. Many machines, of different designs, have recently come to the attention of the public. At present, stove distillate, a more expensive fuel than crude oil, must be used in this style of heating device to avoid bad odors, soot, and the like. Whether the saving in fuel, therefore, counterbalances the difference in price of distillate and of crude oil is an open question. If it does not more than equal this difference, the saving in fuel cost is more apparent than real.

Stack type of air blast drier.—Some commercially built evaporators consist of several stacks or tiers of trays placed one above the other and hot air is forced upward through and over the trays. Whether it is a more logical type than the horizontal blast remains to be seen.

Continuous evaporators have been developed successfully for vegetable drying, soap chip drying, kelp drying, and the like, but have not worked out well for fruits, because of the bruising of the fruit and its sticking to the

belts or conveyers. Essentially, the drier consists of several superimposed metal cloth conveyers or canvas belts in a long tunnel. The material to be dried enters the tunnel on the upper belt, traverses the length of the tunnel, drops to the second belt, and so on until it may travel back and forth five to seven times at such a speed that it emerges from the lower belt dry. If such a machine could be built successfully for fruits, it would doubtless greatly reduce labor costs. It has possibilities and will bear further study and development.

Distillation types of evaporators.

In these evaporators the water is distilled from the fruit and the vapors are condensed.

Atmospheric pressure machines.—In this type the drier is not placed under a vacuum but is, however, rather tightly closed to the outside air. In one form the fruit travels on belts over steam coils. The heat from the coils drives the moisture from the fruit. The vapor passes over water-cooled pipes and is condensed, giving an area of reduced pressure toward which the vapors continually flow. In another type the air and gases of combustion from a furnace heat the fruit and carry the moisture to condensers. This evaporator is really a combination of the distillation and air blast forms.

Vacuum driers.—Insofar as quality of dried product is concerned, the vacuum drier is in a class by itself. No other drier compares with it in its ability to produce dried fruits of fresh flavor, color and aroma. There are two reasons for this, one being the practical absence of air in the vacuum drier, a fact which accounts for lack of oxidation, and a second reason for its superiority is the low

temperature of drying. Temperatures of 100 to 120 degrees Fahrenheit may be used successfully and rapid evaporation obtained. In its commercial form, the drier usually consists of a strong boiler plate chamber with shelves for trays and fitted with steam pipes. To this chamber is connected a vacuum pump and vapor condenser. The air is removed by the pump, the water is driven from the fruit by the steam pipes and is condensed in the spray or other form of condenser. A continuous vacuum drier has recently been built and is a most remarkable machine. Vacuum driers possess great possibilities, probably more than any other evaporator in use, but have not been generally adopted because of their high cost. When such a machine can be produced at a moderate price, it will revolutionize present ideas of evaporation.

CANNING, JELLY MANUFACTURING

The canning apple industry has only recently attained considerable importance. This phase of the by-product business is growing very rapidly in the Shenandoah district of Virginia and West Virginia and in Adams County, Pennsylvania. Considerable apples are also canned in New England, the Middle West and in New York. The Northwest has also taken up the canning industry, but in California, apple by-products are still limited largely to dried fruit. In various parts of the country, advantage has been taken of existing breweries or distilleries in converting them into canning or cider plants. Most of the work in the big canning plants is done by machinery, although it is usually necessary to have the fruit gone over last by hand help in order to detect bits of core or pieces of skin left near the calyx or stem. The process of canning

is much the same as in the case of other fruits and it is impossible to enter into detail here.

Apple jelly is now being manufactured on a considerable commercial scale. It is often made by adding sugar to cider, 100 pounds of cider with 20 pounds of sugar making about 40 pounds of jelly. The refuse from cider and vinegar mills or apple pomace is often employed for making jelly, the pectin found in this apple pomace being the ingredient used. All kinds of fancy and concentrated by-products are made from apples and the scope and uses of these various apple by-products promises to enlarge greatly.

CIDER AND VINEGAR

Cider and vinegar manufacture still absorb most of the apples used for by-products. Enormous quantities are annually made into cider both in the large commercial cider mills and in the smaller mills in the non-commercial regions. Large vinegar plants with storage capacity for millions of gallons have been established in Virginia, West Virginia, New York, New England, the Central West and the Northwest. Considerable difficulty has been encountered with the prohibition law in the manufacture and sale of cider, but it seems fairly certain that rulings will be obtained which will always permit the manufacture of sweet cider. In some of the large cider and vinegar plants where double presses are used, an average of over 9 gallons of cider to 100 pounds of apples is obtained.

CHAPTER XVIII

COST OF PRODUCTION

THOSE regions which are able to produce and market apples at the lowest relative cost will survive the keenest competition. Every grower instinctively endeavors to put his fruit on the market as economically as possible, yet only a very few keep accounts of sufficient accuracy to arrive at even an approximation of their actual cost of production. If the individual grower is unable to give accurate cost production figures, it becomes apparent that the relative cost of producing apples in different regions can only be obtained by detailed and thorough study of the items and operations.

It was the privilege of the authors to study the cost of producing apples in eight of the leading apple states of this country. In the course of this study, extending through several seasons, hundreds of detailed orchard survey records were taken, covering every item and operation which would influence cost of production. It required only a brief study to determine the lack of attention which this important subject was receiving at the hands of the average grower. Many growers would starve under their present lax methods of management if they were wholly dependent on apples, or were it a case of clean-cut competition with the survival of the fittest.

The manufacturer can not long survive if he does not give close attention to production costs. He must not only

know the total cost of production, but also the various items of which it is comprised. Only by knowing these can he be prepared intelligently to lower his cost items. The same principle applies to the apple-grower.

An important point in such a study is to determine which operations are profitable and which are not. A grower should not attempt to lower his costs blindly. He must be thoroughly acquainted with the various items of expense in order that in attempting to lower cost he will not cut corners in the wrong direction and thereby lower production. To neglect fertilizing, thinning, spraying or such important operations would be a case of lowering cost in the wrong direction. It would usually pay to spend more on some of these operations in order to increase production, and thereby lower cost of production a unit. It is merely a case of spending wisely. Those who argue against the necessity of knowing the various costs of production do so through selfish motives or through ignorance.

The survival of any fruit district depends on its ability to produce fruit in competition with other sections. Certain regions by virtue of their extremely favorable location with respect to soil, climate and economic conditions, are firmly established and will always remain prominent in the commercial apple industry. Other regions lacking some of the necessary qualifications can never succeed. In a third class are the marginal districts which lack some of the more desirable qualifications, and yet which in certain years compare very favorably with the best regions. For example, a locality subject to frost might in some years produce a very profitable crop and yet over a period

of years the crop failures would greatly reduce the average returns.

In considering the marginal regions it is necessary to recognize that in a period of low prices they will be the first to suffer in the process of elimination.

Only systematic and careful analysis of the factors entering into and influencing the cost of production will indicate which region will survive and which will fail. Growers have made profitable returns on orchard land at $1,000 to $2,000 an acre in some regions, while others have failed on $100 land in other places.

Cost production varies not only among regions, but among individual growers of the same district. It has been found that it costs some growers 50 per cent more a barrel or box to harvest their crop than it does their more alert neighbors. Some operations, such as spraying, thinning and proper soil management, are exceedingly profitable within certain limits. Without reliable information, the grower can not tell what operations are paying him best on the investment. Often the most expensive operations are the most profitable.

Cost production figures reveal the regions which are best adapted to the commercial production of apples, emphasize the value and relative importance of different cultural methods, show the size of orchard which the grower can operate most economically, indicate the most profitable varieties, and in short reveal all of the best principles in orchard selection and management.

The factors which enter into the cost of production are divided into labor costs and costs other than labor.

The labor costs include both man and horse labor and are

further subdivided into maintenance, or growing labor costs, and handling labor cost. The growing cost includes all the labor required up until the time the apples are ready to pick, while the handling cost includes the labor of picking, packing, and the like, until the apples are put in storage or on board car.

Costs other than labor take in material and fixed costs. Material costs include manure, spray material, fertilizer, cover-crop seed, barrels, boxes, and the like. The fixed costs comprise all overhead charges, such as interest on investment, taxes, the orchard's share of insurance, interest, depreciation on equipment, and apple buildings.

Of these main groups of costs, the labor is most likely to be the limiting factor in successful production. Fixed costs are particularly important in the Northwest on account of high land values.

The various cost items comprising labor, material, and fixed costs are enumerated in Table XV.

TABLE XV.—COST ITEMS IN APPLE PRODUCTION

Labor Costs		Costs Other Than Labor	
Maintenance	*Handling*	*Material*	*Fixed*
Manuring Pruning Disposal of brush Plowing Cultivating Sowing mulch crop Handling mulch crop Propping Thinning Spraying Miscellaneous	Picking Hauling barrels and shooks Hauling to packing-house Packing Sorting Foreman Nailing or heading Other packing-house labor Haul to station	Fertilizer Manure Spray material Box or barrel Labels, paper, etc.	Taxes Insurance Equipment charge Apple house depreciation Interest Water rent

It is not enough merely to learn the cost items, but one should go further and study the influences which determine

them. Such factors as availability and kind of labor, location as to soil, climate, transportation, size of orchard, size and type of farm, varieties and most of all yields, directly influence costs. These are to be particularly considered before they become established in any given region, for once fixed the growers may find it impossible to overcome them should they be unfavorable.

IMPORTANCE OF YIELDS

Yield is the all-important item in determining the cost production a unit. The subject of yields has been given separate treatment elsewhere (see Chapter XVI) but is of such great importance as to require particular emphasis. A yield of 200 barrels an acre means much more profit a barrel than a yield of 100 barrels an acre. Thus there is a large gain, not only in profit to the acre, but in profit a barrel or box as well. This factor is overlooked by most growers. Otherwise more effort would be expended in increasing the yield of commercial fruit in many orchards. It is vastly more profitable to have a yield of 200 barrels to the acre on a ten-acre orchard than 100 barrels to an acre on a twenty-acre orchard. No grower, and especially the beginner, should attempt to handle more acreage than he can take sufficient care of to insure a good yield.

The importance of a high yield is shown in the accompanying table which applies to Hood River, Oregon.

It is seen from Table XVI that the acre cost varies directly with the yield while the box cost varies inversely. For instance, in the case of orchards with a yield of 440 boxes to the acre, there is an acre cost of $412.98 or $.938 a box, while with orchards with a yield of 115 boxes, the

TABLE XVI

RELATION OF YIELD TO TOTAL ANNUAL COST OF PRODUCTION

Yield (in boxes)	Average yield (in boxes)	COSTS									
		Maintenance		Handling		Material		Fixed		Total	
		Acre	Box	Acre	Box	Acre	Box	Acre	Box	Acre	Box
150 and under	115	$56.11	$.4879	$32.60	$.2835	$38.95	$.3387	$95.92	$.8341	$223.58	$1.9442
151 to 200	177	53.15	.3003	48.66	.2749	54.98	.3106	96.45	.5431	253.24	1.4289
201 to 250	219	56.83	.2595	56.06	.2560	69.97	.3195	105.08	.4785	287.94	1.3135
251 to 300	270	69.39	.2570	82.54	.3057	83.81	.3104	101.12	.3745	336.86	1.2476
301 to 400	335	82.91	.2475	102.58	.3062	98.59	.2943	93.66	.2794	377.74	1.1274
Over 400	400	74.18	.1686	121.31	.2757	125.49	.2852	92.00	.2087	412.98	.9382
All Records	320	$88.51	$.2766	$89.63	$.2801	$99.39	$.3106	$99.11	$.3097	$376.64	$1.1770

acre cost is only $223.58, but there is an exceedingly high cost of $1.94 a box. In other words, the lowest yielding orchards have an acre cost of $189.40, less than the highest yielding ones, but a box cost of $1.006 more. A saving of $1.00 a box is not only secured by the highest yield, but the profits are swelled since this saving of $1.00 a box applies to 440 boxes an acre instead of 115. By comparing the yield in boxes in the first column with the total cost a box in the last, the importance of yields is most forcibly brought out.

Attention has been drawn to the fact that with yields averaging 440 boxes an acre, apples are produced in Hood River at a cost of $1.006 a box less than when the yields were only 115 boxes an acre. The handling and material costs for boxes, and the like, increased almost directly with the yield, so there is little saving on a box in these items. However, in the maintenance costs such as pruning, spraying, thinning, and in the fixed costs such as interest on investment, the greatest saving a box is effected for fixed costs an acre, remain practically the same for all yields.

In figuring cost of production, so much must be allowed for interest on investment. If an orchardist has an investment of $1,000 an acre, interest on that amount at 7 per cent would be $70.00 an acre a year. This cost distributed over 440 boxes would be about 16 cents a box; distributed over 115 boxes an acre this cost would amount to about 61 cents a box. As seen from the above, the fixed costs are the group in which the greatest saving is effected by increased yields. Fixed costs such as interest on investment are too often ignored or overlooked by growers who do not realize that these items very often determine the success or failure of an orchard enterprise. The fixed

or overhead cost an acre once established can only be met successfully by increased yields.

Returning to maintenance, it is found that these costs are generally somewhat higher an acre in the high yielding than in the low yielding orchards due to more thorough work, although it is obvious that a dormant spray on a low yielding orchard is about as expensive as that on a productive planting. The maintenance costs on the highest yielding orchards in Hood River were only $18.00 more an acre than on the lowest ones, and yet the saving a box in the case of the former on account of increased yields represented 300 per cent when figured on the box basis. The foregoing principles, although demonstrated by examples from Hood River, Oregon, are applicable to all regions of the United States, whether producing boxed or barreled apples. They demonstrate how and why yields are the all important factor in successfully lowering cost of production.

INFLUENCE OF SIZE OF ORCHARD

The size of the orchard is another important factor in determining cost. Given the same acre yield, the larger the acreage the less the cost of production a unit. Investigations have shown, however, that beyond a certain acreage the yield decreases more rapidly than does the acre cost of production, thereby making the cost a box or barrel higher than in the small orchards. In other words, the decrease in the maintenance, fixed and material cost an acre is often more than offset by the decrease in yield.

In Table XVII, which refers to Hood River, a slight increase is seen in cost a box as the size of the orchard in-

TABLE XVII.— EFFECT OF SIZE OF ORCHARD ON COST A BOX

Acreage.	Yield.	Cost.	
		An Acre.	A Box.
5 and under	406	$458	$1.13
5 to 10 inc.	331	381	1.15
10 to 20 inc.	306	369	1.21
20 and over	284	340	1.20

creases, which is due to the yield decreasing as the size of the orchard increases. It is obvious, however, that with the same yield to the acre in the larger orchards, the cost a box would be very much less.

In this connection it should be stated that in certain sections the economic unit of orchards which can safely be managed is much larger, but in every district there is an economic unit beyond which nine growers out of ten do not make as great a success as the small grower. From investigations in western New York, the economic unit would seem to be from fifteen to twenty acres when the orchard is connected with diversified farming. There are many successful and very progressive growers operating large acreages, but these are specialists as a rule. Theoretically, the larger the orchard the larger the profit, but this does not always work out in practice. Many growers have failed in the apple business because they have figured that a large acreage fairly well cared for would produce more apples and yield more profit than a smaller acreage more intensively looked after and yielding larger annual crops. The most profitable sized orchard, from the standpoint of cost of production, will vary widely in different regions. It is probably the smallest in the irrigated sections of the Northwest and the largest in such regions as

Virginia. The size should be determined very largely by a study of the most successful orchards in any particular community. When tractors are used, the orchards should be larger.

Attention must be given to the prevailing system of orchard operation, to the average annual yields of the region, and to the availability of labor. It is obvious under irrigated conditions when trees make rapid growth, when the yields are heavy and when such operations as irrigation, thinning and the like are intensively practiced, that smaller acreages are advisable. Probably twenty to twenty-five acres is the best size under such conditions.

Western New York growers have found that a bearing orchard of twelve to twenty-five acres fits in well with their system of diversified farming. Virginia apple-growers, less given to diversification, find thirty to forty acres an economic unit, and many succeed with much larger units. It is only the exceptional grower with large working capital and keen business ability who can handle successfully a very large acreage.

EFFECT OF SIZE AND TYPE OF FARM

The size of the orchard in relation to its effect on cost of production has been discussed, but very often the orchard is only one part of a more or less general farm. The size and type of the general farm may reduce profits from the apple orchard by taking away labor at critical seasons, or may increase profits by supplying labor at a low cost. A general farm may insure diversification and a continuous employment and profitable distribution of labor throughout the season. This is largely a problem in farm management.

An interesting chart has been prepared showing the average distribution of man and horse labor on an acre of bearing orchard throughout the season under intensive treatment (Fig. 10).

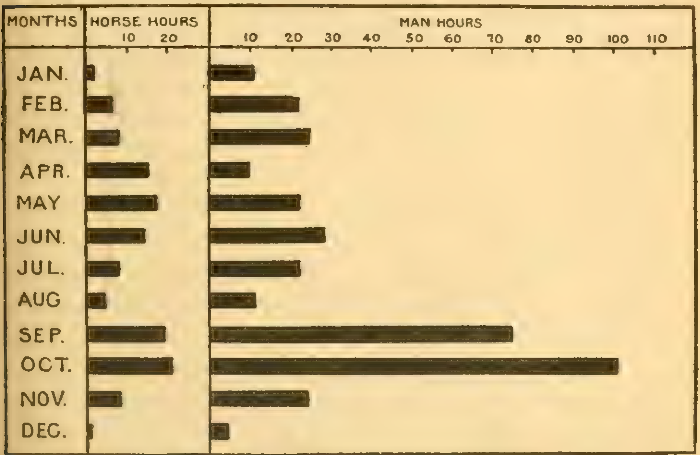


FIG. 10.— Showing seasonal distribution of man and horse labor on the average bearing orchard in irrigated regions.

In specialized apple-growing, there are always long periods of enforced idleness for both man and horse labor, but particularly the latter. If plenty of day help is available at reasonable rates, this labor distribution is not so necessary, but when help is hired by the month, i is of vital importance. If one were certain of high fruit prices at all times, the small, intensified, specialized farm would be justifiable and even advisable, for in such cases a high quality of fruit is usually produced. However, there has to be a provision for the periods of low prices and this can best be met by diversification. That most fruit-farms in

the Northwest are small and intensive has been due to the system of land development. Cost of production in this region is only kept within bounds by high average annual yields. The farms of the East are more diversified and with the same yield as in the Northwest orchards the cost of production is very much less, due not only to a less fixed cost an acre, but to a lower maintenance cost and a more seasonable distribution of labor. It should be added, however, that very rarely do the yields in eastern orchards equal those to the acre from the intensified irrigated orchards of the West.

The size, type and diversification of the farm will depend largely on the initial cost of the land, the adaptability of other profitable crops, and acreage which has proved to be the best economic unit in any particular community. Conditions vary so widely in different districts that no specific recommendations can be made. However, the experience of a community may always be depended on. In every established community there are certain growers or farmers whose success and methods stand out above those of their neighbors. It is well to study the secret of their success in farm management. Care should be taken not to be misled by the very unusual or exceptional farm which employs radically different methods. A particular farm may be successful, either through the extraordinary ability of its owner or through peculiar local conditions of labor and transportation, or on account of a special market. This success may not always be duplicated.

Under eastern conditions, it is usually better to depend on a fair-sized farm, and endeavor to bring it above the average, than to count on a very small acreage cultivated intensively or on a very large acreage which requires

PLATE XXII. — A typical Yellow Newton orchard in the Watsonville, California, district. The young orchard in the foreground is interplanted with squash.

skilled farm managerial ability when its size exceeds that of the economic unit. The prospective buyer or settler should always take into consideration the community practice and the existing economic conditions before investing large sums and plunging into a method of farm management and organization wholly foreign to that region. Such undertakings sometimes succeed, but in most cases they have failed on account of the growers' inability to gauge conditions from a practical instead of a theoretical standpoint. Diversification is generally recommended in lowering cost of production, but it should not be practiced to the neglect of the orchard. Under neglect the orchard usually ceases to be commercial and is separated from the realm of commercial fruit-growing.

EFFECT OF CLIMATE AND SOIL ON COST OF PRODUCTION

The cost of production is affected by climate and soil insofar as these factors determine the yield and quality of fruit and govern cultural methods. In humid climates the cost of spraying is usually greater, on account of fungous troubles. In arid climates, however, there is the added cost of irrigation. Some soils are easily cultivated and adapted to tree growth. Others are poor in plant-food and difficult of cultivation. Soil has such a very direct bearing on yield that it is well to study the yield on different soils. Only average yields should be considered. For example, when the average yield an acre of fifty commercial orchards in one district is fifty barrels below that of a similar number of commercial orchards in another district, it is usually safe to assume that this difference is due to soil. Often this may be overcome by scientific and intelligent treatment, although no other test is quite so

indicative of the adaptibility of apples to any certain region as the average yield. It is not more difficult to rise above the average in a naturally high yielding community than in a low yielding one, and the grower ordinarily would better strive to improve a good soil than to build up a poor one. The question of soil influences cost of production so greatly as to warrant the most careful consideration.

Climate determines in a broad way where apples may be grown. Apples are confined to the temperate zone. In the United States, the irrigated valleys of the Northwest, the northern states, and the higher portion of the southern states are best adapted, and yet throughout these regions frost does enormous damage to the apple crop every year. There are certain favored sections which frost seldom damages, such as the Wenatchee Valley of Washington and certain limited sections in the East. Freedom from frost damage means greater annual yields and consequently more profit and less cost of production.

INFLUENCE OF VARIETIES

Varieties influence cost of production, inasmuch as some are more easily grown than others, and there is a wide difference in yield in orchards of the same age and under like conditions of management. Such varieties as Esopus, Arkansas Black, Winter Banana and Newtown are more costly to grow and produce than Ben Davis, Winesap, Baldwin, Greening and York. Ben Davis, although one of the lowest priced apples in the market, is one of the heaviest yielders and is no doubt generally produced at a lower cost than any other commercial apple. The following table shows the relative cost of production a unit of bar-

rel or box of various commercial varieties. It is based on cost production studies conducted in the leading apple states:

TABLE XVIII.— COST OF PRODUCTION A UNIT OR BARREL OR BOX

High Cost.	Medium Cost.	Low Cost.
1. Tompkins King	1. Hubbardston	1. Ben Davis
2. McIntosh	2. Fameuse	2. York Imperial
3. Yellow Newtown	3. Winesap	3. Rome Beauty
4. Arkansas	4. Stayman	4. Tolman Sweet
5. Winter Banana	5. Black Twig	5. Limbertwig
6. Esopus (Spitzenburg)	6. Baldwin	6. Yates
7. Northern Spy	7. R. I. Greening	7. Yellow Bellflower
8. Grimes	8. Gravenstein	8. Duchess
9. White Pearmain	9. Jonathan	9. Wealthy
10. Gilliflower	10. Delicious	10. Fallawater
11. Lady Apple	11. Maiden Blush	11. Smith's Cider
12. Bonum	12. Missouri Pippin	12. Willow Twig

Most of the varieties included under high cost of production are of high quality. Most of them are produced only in limited quantities, due either to the inherent delicacy of the trees or their light yielding tendencies. All command a high price in the market.

All those given under medium cost are widely grown and are generally good yielders. The column under low cost includes many highly important commercial varieties, but most of these are of low dessert quality. It seems to be a rule that, in general, the low dessert quality apples are the highest producers and consequently the lowest in cost of production, while the high quality apples are highest in cost of production and lowest in yield. It will be noted that there are exceptions to this in all the columns and in the case of some varieties that are not recorded. Many of the high cost varieties are late bearers.

ACCESSIBILITY TO MARKET

Distance and accessibility to shipping point are factors which have an important bearing on the cost of production. For example, in many sections of Virginia and Carolina, apples are produced fairly cheap on the trees, but a long haul, often of ten to twenty miles over rough roads, adds very materially to the cost of delivery, f. o. b. shipping point. Not infrequently a charge of forty or more cents a barrel must be made to cover the cost of hauling apples to the railroad station. Usually such orchards are situated on low-priced land and have a low overhead charge or fixed cost. For comparison, in Hood River, Oregon, the fixed cost is practically \$.31 a box, or \$.93 a barrel, while in the mountains of Virginia and Carolina the fixed cost is often not more than one-tenth of this amount.

While cost of production usually includes only the cost f. o. b. at loading station, to this figure should also be added the cost of delivering the fruit to the consuming markets in order properly to compare one region with another.

COST OF MATERIALS

The cost of materials is one of the direct factors to be considered in cost production. The material cost, however, does not vary greatly in different regions and therefore is scarcely a limiting factor. It is important to recognize, however, that the price of spray material, fertilizer, barrels and boxes may be lowered materially by coöperation and judicious purchasing. Examples in lowering the costs by these methods may be found in the apple districts of the Northwest.

LABOR AND COST PRODUCTION

Farm and orchard labor varies greatly in the different sections of the country with respect to its efficiency, intelligence, and the rate of wage paid. While daily wage rates may be high, they may be more economical in the end, due to greater efficiency. The following table shows the amount of apples which the average laborer picks in a full working day in several of the leading fruit regions. This refers to day labor unless otherwise stated. In the fall of 1919, however, picking by the box system came into use in the Northwest and many under this system averaged 150 boxes a day. Picking by the box, however, is not always satisfactory as it promotes carelessness and consequent damage to the quality of the fruit.

TABLE XIX.— AMOUNT OF APPLES PICKED IN ONE DAY

Yakima, Washington	60 loose boxes,	20 barrels.
Wenatchee, Washington	75 " "	25 "
Hood River, Oregon	60 " "	20 "
Watsonville, California	54 " "	17 "
Western Colorado	57 " "	19 "
Western New York (day labor)		20 "
Western New York (contract labor by barrel)		25 "
Piedmont District of Virginia		10 "
Southern Ohio		11 "

The orchards in the Piedmont district of Virginia are usually on hillsides and for that reason picking is more difficult. Furthermore, the question of yields is involved. However, it may be seen from the above that it is not impossible for cheap labor to be the most expensive. There is as much complaint over labor costs in the South as in any other part of the country. In regions of general farming, labor is usually cheaper than in specialized sections since it can be employed profitably for a longer

season. General farming permits the employment of month labor at a lower wage than must be paid for day labor. On the other hand, labor in general farming communities is not likely to be as skilled as where apple-growing is the most important industry. The efficiency of labor is an important factor in the cost of production.

ORCHARD MAINTENANCE

Labor is the most important item in orchard maintenance, which involves such operations as pruning, cultivating, thinning and spraying. It will be seen from the following table that maintenance labor costs vary widely in different regions according to the intensity of the cultural practices.

TABLE XX

MAINTENANCE LABOR COST IN SEVEN IMPORTANT APPLE REGIONS

Region.	Hours per Acre.		Cost [1] of labor.	Packed Yield per acre.	Cost per bushel.
	Man.	Horse.			
Western New York	77	63	$49.70	252 bu.	$.197
Yakima Valley	214	91	134.30	432 bx.	.311
Wenatchee Valley	230	96	143.80	593 "	.242
Hood River	142	82	88.51	320 "	.277
Southern Idaho	177	72	110.10	337 "	.327
Western Colorado	161	76	103.30	284 "	.364
California (Watsonville Dist.)	89	54	60.70	226 "	.269

[1] Man labor rates in these regions varied from 40 to 50 cents an hour while horse labor was figured at about 30 cents an hour.

The above table is a summary of the maintenance labor costs on approximately 700 commercial apple orchards in various parts of the United States. Detailed orchard

records and yields covering a period of five years are the basis for these figures which reveal some very surprising facts. Particular attention is called to the variation in amount of man and horse hours expended in maintaining orchards in different regions. The amount of labor does not change materially and is, therefore, a better guide than labor costs which do vary with labor rates. Maintenance labor is that expended in the following operations: Manuring, pruning, disposal of brush, plowing, cultivating, sowing mulch crop, handling mulch crop, propping, thinning, spraying, irrigation and miscellaneous.

Western New York growers expend annually only 77 man hours and 63 horse hours an acre in these operations. Apple-growers in Wenatchee do not use many more horse hours to the acre, but expend three times the amount of man labor an acre than is given for western New York orchards. That such intensive methods are profitable is shown by the increased yields and high marketable quality of fruit produced. After spending $94 an acre more in maintenance, the Wenatchee grower, by increased yields, is able to keep his maintenance costs at a figure only 4½ cents a bushel greater than the New York grower.

It is interesting to note that the amount of horse labor to the acre does not vary greatly in the different regions, while the man labor varies 300 per cent, being greater in the Northwest where such intensive practices as thinning and irrigation require man labor, but little or no horse labor.

Cost of pruning and brush disposal.

The following table will serve to show pruning practices and costs in several important regions:

Table XXI

Pruning and Brush Disposal — Relative Time and Costs in Different Regions

Region.	Man hrs. per acre	Horse hrs. per acre	Cost of labor	Cost of bushel	Trees per day
Western New York	31	6	$14.20	.06	14
Yakima	64	11	35.30	.08	14
Wenatchee	52	14	30.20	.05	19
Hood River	30	7	15.60	.05	30
Southern Idaho	58	9	31.70	.09	13
Colorado	62	11	34.30	.12	14
California (Watsonville Dist.)	31	7	17.60	.08	23

In all apple regions, pruning usually represents at least one-fourth of all labor expended up until the time of picking. Although the northwestern growers spend more labor to the acre in pruning, it must be remembered that there are nearly twice as many trees to the acre as in such regions as western New York. Cost production studies reveal that the importance of pruning is generally recognized. The amount of pruning necessary varies widely with the variety. In the Hood River Valley, the Yellow Newtown and Esopus Spitzenburg which predominate in this region do not require nearly as much pruning labor as the more vigorous or rampant growing varieties.

Pruning cost a bushel of marketable fruit produced averages from 5 to 8 cents, of which about 2 cents is represented by the cost of handling brush.

Soil management.

Different systems of soil management make the cost of this operation exceedingly variable. One would imagine with the general intensive cultural methods of the Northwest that soil management would represent a considerable cost item in this region. As a matter of fact, the value

of the shade crop usually grown in the orchard more than pays for the cost of soil management plus irrigation in the Northwest. Under the old systems of clean cultivation, the northwest grower expended from $15 to $20 an acre in soil management. By growing alfalfa as a shade crop and taking off one or two cuttings, he makes about enough to pay soil management costs. Some of the best authorities maintain that in taking off two or more cuttings of alfalfa, the grower is depleting soil fertility. It is to be questioned whether it is advisable to remove more than one cutting.

For eastern and middle western orchards, with the exception of those in sod mulch, soil management involves about the same amount of labor to the acre as does pruning, since about 25 per cent of all the labor spent in growing apples up until harvest is in cultivation or other labor on the soil. Western New York growers expend about 13 man hours and 28 horse hours to the acre in soil management.

The greatest saving in sod mulch orchards in the East is in the absence of any expense for soil treatment. However, this saving is usually more than lost in decreased yields.

It is of interest to note the number of acres one man and team will cover a day with the ordinary cultivation tools.

Table XXII.— Acres a Day for One Man and Two Horses

	Irrigated Regions.	Eastern Regions.
Plow	1.5	2
Disc	5.5	7
Spring-tooth	6.5	10
Spike-tooth	10.	12

The northwestern grower covers a less number of acres a day with each cultivating tool than does the eastern grower. This is partly explained by the fact that there are practically twice as many trees to the acre in the irrigated sections, thus necessitating more care than in the East. The orchards in the irrigated sections are often inter-planted with shade crops as alfalfa, and in such cases operations like plowing and discing necessarily require considerable time and labor.

Thinning.

The practice of thinning varies so greatly that a study of the extent and cost of this operation in several different regions will be of particular interest.

TABLE XXIII.— THINNING PRACTICES AND COSTS

Region.	Yield per acre.	Man hrs. per acre.	Cost per acre.	Cost per bushel.
Western New York	252 bus.	4	$1.60	$.0063
Yakima	432 bxs.	49	24.50	.0567
Wenatchee	593 "	53	26.50	.0447
Hood River	320 "	25	11.25	.0352
Southern Idaho	337 "	47	23.50	.0697
Western Colorado	284 "	18	9.00	.0317
California (Watsonville Dist.)	226 "	14	7.00	.0310

A sharp contrast is brought out when the average amount of thinning in such regions as western New York is compared with the heavy thinning in the Northwest in such districts as Wenatchee Valley. The average New York grower expends only 4 hours an acre in thinning his apple crop. The average Wenatchee grower devotes 53 hours labor to the acre in thinning, but when the cost of this

labor is distributed over the average yield, it amounts to less than 5 cents a box. When one considers the higher annual yields and the greatly improved quality directly due to thinning, it may readily be seen that to omit thinning is to cut costs in the wrong direction.

From the standpoint of economy, the writers are convinced that not only will thinning improve quality, but that it will actually lower cost of production by increasing annual yields.

Spraying.

The cost of spraying is discussed in Chapter X.

HARVESTING COSTS

Harvesting costs include all the labor and material costs incident to picking, packing and delivering fruit to the station. These represent from 40 to 50 per cent of the cost of producing apples. It might be stated here that fixed costs, such as interest on investment, represent about 20 to 25 per cent, while maintenance costs for such operations as thinning and spraying, represent from 25 to 30 per cent of the total cost of production.

In Table XXIV is shown the amount of labor necessary for harvesting crops in several different regions and also the cost a bushel for labor and material incident to harvesting. It is seen that all harvesting costs make up from 45 to 50 per cent of the total cost of production.

It is interesting to note that labor cost for harvesting boxed apples is but little greater than for barreled apples, while five years ago it was nearly 100 per cent greater. Labor rates have increased more proportionately in the barrel apple regions than in the box sections. It now costs most barrel sections nearly 25 cents a barrel for picking.

Table XXIV.— Total Harvesting Cost

(Cost refers to marketable fruit only.)

Region.	Yield per acre.	Labor cost per packed bushel.	Labor & Material cost per packed bushel.	Per cent. of total cost of production.
Western New York	252 bus.	$.2235	$.4402	50
Yakima	432 bxs.	.2775	.5600	47
Wenatchee	593 "	.2775	.5600	48
Hood River	320 "	.2801	.5251	45
Southern Idaho	337 "	.2775	.5600	49
Western Colorado	284 "	.2775	.5600	45
California (Watsonville Dist.)	226 "	.2650	.5050	48

Other harvesting and packing labor, aside from the picking, averages about 1.8 barrels to a man an hour. This is the case in New York, the Middle West, and commercial sections of Virginia. The western grower figures that he is repaid for any extra cost in handling and packing his crop by increased returns for his fruit. The secret of his success on the market has been due to this intensive effort.

Table XXV shows fixed costs, including charges for interest on investment, for several important apple regions.

The fixed costs, as before stated, comprise those annual

Table XXV.— Total Fixed Costs

Region.	Yield per Acre.	Interest charge		Total Fixed Cost		% Total Cost of Production.
		per acre.	per bu.	per acre.	per bu.	
Western New York	252 bus.	$26.	$0.10	$34.	$0.13	15
Yakima	432 "	86.	.20	114.	.26	22
Wenatchee	593 "	154.	.26	187.	.32	27
Hood River	320 "	79.	.25	99.	.31	26
Southern Idaho	337 "	49.	.15	63.	.19	16
Western Colorado	284 "	52.	.18	72.	.25	20
California — (Watsonville Dist.)	226 "	41.	.18	49.	.22	21

charges, the acre cost being little affected by the size of the crop. Fixed costs include taxes, depreciation, insurance, and interest on investment. Of these, interest on investment is by far the most important. This item alone reaches $154 annually in the Wenatchee Valley, a cost which is a good price for land in many sections. Western New York had an interest cost an acre of only one-sixth this amount. The high yields of the Wenatchee Valley, however, tend to overcome this high interest charge. Figured on the bushel basis, the interest charge at Wenatchee was 26 cents a bushel as compared with 10 cents a bushel in New York state. This fixed cost has not increased in most apple sections since 1914, while labor rates have advanced about 100 per cent and cost of material rose sharply in 1920.

Hood River, Oregon, has an annual acre interest charge of $75 less than that for the Wenatchee Valley. Returning to the interest cost a box, it is seen that Hood River is charged with 25 cents a box as compared with only 26 cents for Wenatchee. This serves to show very emphatically that high costs a box or barrel are to be considered irrespective of fixed costs an acre, for yields directly determine fixed cost a box or barrel.

On the other hand, it is important to remember that any saving in fixed cost is direct. This may be effected in the judicious purchase of land. It is always poor economy to grow apples on poor land, but at the same time orchards are over-capitalized in many regions and the grower of limited means will sometimes find his fixed cost so high in a series of poor years that he will not be able to survive the hard times. It should be repeated that once these fixed costs to an acre are established, they can not be low-

ered and can only be met successfully by increasing and maintaining yields.

Much more detail might be entered into in a discussion of the cost of production in the various regions. It is constantly changing with the price of labor and materials. It is important to cut out all unnecessary expense in connection with the orchard and pay strict attention to yield of high quality fruit. However, expenses to the acre should not be spared if it decreases expense a box or barrel. Almost universally the grower who spends most on his orchard when invested in a systematic way, such as proper pruning, fertilizing, thinning and spraying, produces apples at a less cost a box or barrel than the grower who tries to save dimes by lack of sufficient attention to the orchard and loses dollars by lack of a good yield.

When selecting an orchard or site, it is extremely important that probable cost of production be studied and taken into account. The limiting factor which determines the success or failure of a region may be climate, soil, transportation, topography, labor, cost of materials or one of many other things. Above all, it is most important to remember that large annual yields of high quality fruit will overcome most unfavorable factors. In fact, high yields are in themselves proof that most factors are either favorable or, if unfavorable, may be overcome. Yields should be based on an average of at least five years. Misleading statements as regarding yields are often wilfully made in various commercial publications for advertising purposes. Acreage averages should be used and not tree averages. One is likely to draw erroneous conclusions from the performance of individual trees.

If cost production figures are based on the average an-

nual yields for bearing commercial orchards in a community, the results will indicate the relative success of the average grower. By intelligent handling, the progressive grower usually finds no difficulty in rising above the community average. If the average man is making a good profit, the exceptional grower should made a still better one.

Table XXVI is a summary of all costs and is based on 1919 conditions. The cost a box varies from \$1.05 in California to \$1.25 in Colorado. The northwest irrigated regions vary in cost of production from \$1.15 to \$1.20 a box. Average western New York costs amount to \$2.62 a barrel f. o. b. All these costs are based on yields of marketable fruit. Cull apples are not credited. However, as these orchards represent those producing fruit for the commercial box or barrel market, the percentage of cull fruit is small. In fact, the average annual credit from the cull fruit has been found in most instances practically to balance the annual orchard depreciation. These two more or less variable and uncertain factors, may, in general then, be said about to balance.

Orchard heating is another cost which sometimes occurs in certain regions but this cannot be given consideration as it is now seldom practiced in apple orchards and is very generally discredited. The high cost has been found to make it prohibitive and unprofitable in most cases and particularly in western Colorado where at one time it was widely practiced.

CONCLUSIONS

1. Cost of production in any region depends primarily on the yield of marketable fruit. It varies inversely with

Table XXVI

Total Cost of Production an Acre and a Bushel in Some of the Leading Apple Regions

Regions	Yield	Maintenance		Handling		Material 1		Fixed		Total	
	Bu.	Acre	Bu.	Acre	Bu.	Acre	Bu.	Acre	Bu.	Acre	Bu.
Western New York.	252	$49.70	$.197	$56.32	$.2235	$81.09	$.3218	$33.57	$.1332	$220.68	$.8755*
Yakima Valley.....	432	134.30	.311	119.88	.2775	148.26	.3432	113.75	.2633	516.19	1.1950
Wenatchee Valley..	593	143.80	.242	164.56	.2775	189.88	.3202	186.91	.3125	685.15	1.1549
Hood River.......	320	88.51	.2766	89.63	.2801	99.39	.3106	99.10	.3097	376.63	1.1770
Southern Idaho....	337	110.10	.327	93.52	.2775	120.58	.3578	63.32	.1879	387.52	1.1502
Western Colorado..	284	103.30	.364	78.81	.2775	101.84	.3595	71.60	.2521	355.55	1.2521
California	226	60.70	.269	59.89	.2650	67.10	.2969	49.72	.2200	237.41	1.0509

1 Includes barrel container in New York and box in other sections.
* Cost a barrel for Western New York is $2.62. See conclusions for 1920 costs.

yields; the higher the yield, the lower the cost of production a unit.

2. Maintenance practices such as spraying, pruning and cultivating, greatly influence yield. As a general rule, increase in maintenance costs to the acre means a decrease in cost a box or barrel. It is poor economy to neglect orchard practices which are necessary to high yields of good quality fruit.

3. The average commercial grower in the United States could effect a considerable saving in his cost of production if he spent more time in thinning his fruit. At the present time only growers in the Pacific Northwest thin extensively. Even there this operation could be practiced more systematically with profit.

4. Growers with mature orchards or those reaching maturity can in many cases greatly increase annual yields and thereby lower cost of production, if they will give more attention to soil management and fertilization. No phase of fruit-growing is of more importance than the maintenance of soil fertility.

5. The relative acre value of apple orchards should be determined largely by average annual yields. Low yields with excessive fixed costs limit successful production in many widely advertized regions.

6. The cost of production is exceedingly variable depending so largely on yield, labor rates and overhead costs, all of which are so variable that no definite figure which will hold can be given. However, it has been found that under 1919 conditions box apples could not be put in the car for less than $1.20 a box, while barreled apples ordinarily averaged about $2.50 a barrel, f. o. b., in cost of production. The cost of boxes was figured at 22 cents, of

barrels 60 cents. Labor was figured at 40 to 50 cents the hour and materials were charged at the 1919 rate. Changes should be made accordingly. Increased price of packages brought the 1920 cost of production of boxed apples to about \$1.30 and of barreled apples to about \$3.50.

CHAPTER XIX

VARIETIES OF APPLES

THE proper selection of varieties should be given careful consideration by the commercial apple-grower since this may determine the success or failure of his enterprise. Hundreds of varieties of apples are grown in the United States and many hundreds of others are described in pomological lists. It is interesting to note, however, how relatively few varieties make up the commercial apple production of the United States. Twelve varieties represent nearly 80 per cent of the commercial apple crop of the United States. Such a limited list would probably include Ben Davis, Baldwin, Rhode Island Greening, Winesap, Jonathan, Northern Spy, Yellow Newtown, York Imperial, Delicious, Stayman, Grimes and Wealthy. These varieties are not of recent origin, but are almost without exception old and well established sorts known to the commercial grower for generations.

Baldwin has been known since the middle of the eighteenth century, while Ben Davis was propagated over one hundred years ago. Jonathan was first exhibited in 1829, while Northern Spy has been famous for its high dessert and market qualities for over one hundred years. Rhode Island Greening was highly recommended as long ago as 1800 and the same is true of Tompkins King. Yellow Newtown has been prized for its good qualities for almost

two centuries, while the good qualities of the Winesap apple were known as long ago as 1817. Oldenburg (Duchess), the planting of which has become very extensive in recent years, is a very old European variety which was introduced in this country as long ago as 1835.

Yellow Bellflower, one of the leading varieties of California and well known throughout the country, has been noted for its dessert quality for one hundred years. Stayman, which is ordinarily classed as new, bore fruit as early as 1875. Grimes was a commercial sort in 1800. Esopus Spitzenburg was grown in the Hudson Valley over a century ago. The Delicious is about the only variety of recent origin which has grown to great popularity and forced itself on practically all the commercial markets.

This brief discussion serves to emphasize how hard it is for any variety to become well known in commercial channels without many years of thorough trial and an acquaintanceship with the public. It further serves to emphasize how really few kinds survive. It is said that approximately 7,000 varieties of apples have been described in pomological publications since 1804. Of these, very few are of commercial importance to-day. This does not preclude the possibility of developing new and better kinds, but the commercial grower has found it profitable to limit the number of his varieties and allow others to experiment with new or doubtful ones.

In every region, from four to six well-known varieties have proved most profitable, and it is the safest plan to select three or four from this list and plant new varieties only in limited quantities. In the early history of commercial apple-growing, it was necessary to experiment with untried varieties since no one knew exactly what ones

were best adapted to the different regions. Most of this pioneer work has been done, however, and it is no longer necessary to take chances with strange varieties.

In a discussion of varieties, the question of relative flavor of the same sort grown in different regions arises. An interesting investigation has been conducted by the Bureau of Chemistry, United States Department of Agriculture, which reveals that there is essentially no difference in chemical constituency between normal specimens of apples of the same variety grown in different regions. The percentage of water content and solid matter is practically the same. This investigation, of course, did not pertain to the physiological or cell-structure of the apples, and it may be true that some difference exists in this respect.

A western apple forced by unwise irrigation, or picked green, will not compare with the choicest specimens of eastern apples. One region may grow one or two varieties to great perfection in quality and flavor, while another will grow superior apples of some other kind. New York has its Baldwin and Rhode Island Greening; Virginia its York Imperial, Yellow Newtown (Albemarle Pippin) and Winesap; the central states their Ben Davis, Jonathan and Wealthy; the West its Delicious, Jonathan, Winesap, and so on.

Seed selection and hybridization have been responsible for the improvement of many cultivated plants and for the discovery of many new varieties, but not so for the cultivated fruits. Practically all varieties of fruit are the result of chance discovery of seedlings. The apple does not come true to seed, but is propogated by grafting a cion or bud from a known variety on a seedling root. Plant-

breeding is a much discussed subject and the layman may conceive that new varieties of apples are being developed by this method. As a matter of fact, the experiments thus far conducted in crossing different varieties of apples have been very inconclusive and unsatisfactory.

New varieties are being constantly discovered and very often widely advertised. Some are worthy and some are not. The most noted new variety is the Golden Delicious which is being planted very extensively and in the next decade will appear in most of the commercial markets. Wherever tried, it has proved productive and highly profitable. The grower may experiment but should not plant new varieties extensively before they have been firmly established, or have proved profitable. High quality varieties are very often the most profitable, but occasionally they prove undesirable on account of their tendency toward shy bearing. The Ben Davis apple, on account of its high annual yield, has proved more profitable over a period of years than some of the better quality varieties. The public, however, is becoming more fastidious in its selection, and in the competition between high and low quality apples some of the latter are being crowded out.

Seldom do two varieties ripen at exactly the same time, and with a maximum of four or five leading kinds there is usually a sufficiently long harvest period to permit of the most economical harvesting practice. Buyers and even coöperative organizations insist on a limited number of varieties, and prefer them in carlots. The grower with a miscellaneous list of varieties is the last to sell his crop, whereas the one with two or three kinds of uniform size and color has a decided advantage in the market. The farmer planting a home orchard selects a few trees of each

PLATE XXIII.—Seven-year old Spitzenburg orchard in the Northwest. Alfalfa is grown as a shade crop and two or three cuttings are taken off.

of several varieties, in order that he may have a continuous home supply during the late summer, fall and winter months. The average commercial grower does well to select three or at most four varieties. This choice should not be difficult. Certain regions are adapted to well-known varieties. The consuming public is familiar with the name and quality of these and has come to demand them. Were one to plant an orchard in western New York, the varieties should be largely Baldwin and Greening, with possibly some Twenty Ounce, Duchess or Wealthy. Delicious, King David and others may prove profitable, but Baldwin and Rhode Island Greening have stood the test of trial. Baldwin, Rhode Island Greening, Ben Davis, Northern Spy and McIntosh are successfully grown in the Hudson Valley, although proximity to New York City might warrant planting one or two varieties of summer apples, such as Oldenburg, Gravenstein or Williams. In the Champlain district of northern New York and Vermont, the Fameuse, McIntosh and Northern Spy are suited to these northern latitudes. Across in New England the Baldwin, Northern Spy and Rhode Island Greening predominate, with McIntosh, Fameuse, Wealthy and others following in importance.

In Virginia, the commercial crop virtually consists of six varieties, Albemarle Pippin (Yellow Newtown), Ben Davis, York Imperial, Winesap, Stayman and Delicious. In the Ohio Valley, Rome Beauty and Ben Davis lead; in Michigan, the leading varieties are Northern Spy and Baldwin. In the Ozark region Ben Davis, Gano and Jonathan predominate. Western states have a somewhat larger list of leading kinds. Each district has a host of other varieties, but geographic distribution of the really

important sorts is comparatively simple and it should not be hard to determine for any one locality the varieties which really have proved successful. It is by no means intended that prospective growers should select only from the few kinds named below, but rather than risk untried varieties it might be wise to select from such old ones and those best adapted to the particular locality.

The following are some of the standard varieties grown successfully, and recommended for planting in the various regions:

Western New York —
Baldwin, Rhode Island Greening, Ben Davis or Gano, Oldenburg (Duchess), Wealthy, Twenty Ounce.

Hudson Valley —
McIntosh, Rhode Island Greening, Baldwin, Wealthy, Oldenburg, Northern Spy.

Vermont and Champlain District —
McIntosh, Northern Spy, Fameuse, Wealthy, Gravenstein.

New England —
Baldwin, Rhode Island Greening, McIntosh, Wealthy, Gravenstein, Williams Early Red.

New Jersey —
Stayman, Oldenburg, Winesap, Williams Early Red, Wealthy, Yellow Transparent, Starr.

Delaware —
Stayman, Gano, Yellow Transparent, Williams Early Red, Wealthy.

Piedmont of Virginia —
Yellow Newtown (Albemarle Pippin), Winesap, Stayman, Grimes (top worked).

Southern Pennslvania —
Stayman, York Imperial, Grimes, Oldenburg (Duchess), Yellow Transparent.

Shenandoah Valley of Virginia —
Stayman, York Imperial, Ben Davis or Gano, Grimes,

Winesap (in southern end of valley), Yellow Transparent, Oldenburg (Duchess).

Mountain Region of North Carolina —
Stayman, Winesap, Ben Davis or Gano, Delicious, Arkansas (Black Twig), Bonum.

Mountain Region of Georgia —
Yates, Terry's Winter, Stayman, Arkansas, Yellow Transparent, Delicious.

Southern Ohio —
Rome Beauty, Ben Davis, Grimes, Stayman, Oldenburg (Duchess), Yellow Transparent, Wealthy.

Northern Ohio —
Baldwin, Rhode Island Greening, Northern Spy, McIntosh, Oldenburg (Duchess), Yellow Transparent, Wealthy.

Illinois —
Wealthy, Oldenburg (Duchess), Red June, Yellow Transparent for extreme southern part of state. Jonathan, Stayman, Delicious, Gano and Grimes (double worked) for south central and western Illinois.

Ozarks —
Jonathan, Stayman, Winesap, Gano, Black Ben, Grimes (double worked), Yellow Transparent.

Missouri River Region —
Ben Davis, Gano or Black Ben, Jonathan, Winesap, Wealthy.

Michigan —
Northern Spy, Ben Davis, Baldwin, Rhode Island Greening, McIntosh, Wealthy, Oldenburg (Duchess).

Western Colorado —
Jonathan, Winesap, Gano.

Wenatchee and Yakima Valleys —
Jonathan, Winesap, Delicious (Red and Golden), Stayman, Rome Beauty, Yellow Newtown, Grimes, Winter Banana.

Hood River Valley, Oregon —
Yellow Newtown, Esopus (Spitzenburg), Ortley.

Pajaro Valley, California —
Yellow Newtown, Yellow Bellflower.

The varieties which will be discussed individually in

this chapter may assist in outlining in more detail the geographic distribution of the commercial sorts. It is interesting to note how many of these most desirable varieties are not new discoveries, but are over a hundred years old.

SUMMER VARIETIES

The question of summer varieties requires separate treatment. In their selection, the proximity to markets is an important factor. The great perishability of early apples limits their production to such regions as have access to ready markets.

It is sometimes suggested that the commercial grower may well have a number of varieties ripening at different times in order to supply the demands of local or nearby markets throughout a long season. In some instances this may be advisable, particularly in the case of small growers in the vicinity of large cities, who do most of their own work and where the orchardist or a member of his family markets the fruit locally. The extra expense of harvesting apples in small quantities is a strong argument against too wide diversification.

The growing of summer varieties has proved very profitable to many growers who are so situated that their fruit reaches the market in advance of that from other regions and to growers who cater to local and special markets. A light soil which warms up early is essential.

It is difficult to draw a sharp line between summer, fall and winter varieties. A variety may be known as a fall sort in one section and as a winter in another. It is probably safer to make an arbitrary distinction based on harvesting dates rather than on varieties. Summer kinds in-

clude those normally consumed before September 15th; fall varieties, those normally disposed of by November 15th; and winter sorts those consumed after November 15th. Were there only the two classes, summer and winter, it might be well to include among summer varieties those which are consumed normally before October 15th.

Winter varieties are usually considered as those commonly held in storage. The dates of ripening of the same variety in different regions sometimes works to the advantage of the earlier sections. One instance of the kind is found in the Pecos Valley of New Mexico, where Jonathans mature earlier than in the other western apple districts. For this reason, New Mexico Jonathans have a distinct advantage in the Texas markets. Variation in ripening dates is further exemplified in such northern states as Wisconsin and Minnesota, where varieties considered in some sections as strictly summer apples do not ripen until fall. The Oldenburg (Duchess) is an example of this kind. The Baldwin apple, generally known, and particularly in New York and New England, as a strictly winter variety, is considered a fall apple in some parts of Maryland and Virginia.

LATE VARIETIES

The following varieties, divided into early and late, are arranged in their order of importance in total commercial production. They are discussed from a commercial standpoint, with reference to their adaptation and distribution throughout the different apple regions of the United States. No consideration was given to home orchard production in establishing order of importance.

Baldwin (Plate XXI).

Approximately 50 per cent of the commercial apple production in New York and New England consists of Baldwins. This variety is said to have originated as a chance seedling in Massachusetts in about 1740. While its culture is largely confined to these states, to Michigan and the northern parts of Ohio and Pennsylvania, it is the leading commercial apple in the United States. The question of selecting Baldwin for commercial planting outside of this region should be considered very carefully, but within these confines it is almost invariably a wise choice.

In more southern latitudes, the fruit ripens early and tends to drop prematurely, while in northern New York and upper New England the wood sometimes winter-kills. The tree is strong, large and vigorous, the many old Baldwin orchards in western New York testifying to its longevity. While somewhat late in coming to full bearing, and once matured inclined to biennial bearing, in total production the Baldwin tree is one of the heavy bearers, and in commercial importance it stands preëminent. The ideal Baldwin soil is a fine sandy loam underlaid by plastic light clay or heavy silt loam. The fruit is of good quality, stands shipment and keeps comparatively well, although it sometimes develops Baldwin spot both before and after picking. The Baldwin crop is shipped almost exclusively in barrels and much of it is used for culinary purposes. The selling price, while not the highest, is usually firm. The variety figures prominently in the export trade.

Ben Davis.

The Ben Davis comes next to the Baldwin in commercial importance on account of its wide distribution. It is thought to have originated in the southern states about 1800 and has been a leading commercial variety for many years, particularly in Missouri and Arkansas where, with the Gano, it represents from 60 to 80 per cent of the commercial production. The Ben Davis apple has played an important part in nearly every commercial apple-growing region in this country, and thrives in nearly all but the most northern states. The tree is strong and vigorous, with upright form, and seldom breaks under heavy loads. It comes into bearing early and yields large annual crops. Unquestionably Ben Davis production is rapidly on the decline. Very few trees of this variety are being planted anywhere in the country. Its susceptibility to the Illinois blister-canker has been the cause of heavy loss in trees all through the Ozarks, Missouri River region and Illinois. This susceptibility seems the one weakness in the tree.

The fruit ranks lowest in dessert quality of all leading varieties, yet for cooking, shipping, and keeping qualities, it stands among the best. Ben Davis is important in the Northwest where it is boxed. In the Ozarks and Middle West it is shipped both in bulk and in barrels, and in eastern states, principally Virginia, it is largely barreled.

It is adapted to a very wide range of soils, perhaps more so than any other standard variety. Despite low prices, Ben Davis has unquestionably been a profitable apple on account of its large annual yields. From a strictly monetary standpoint, and over a long period of years, commercial growers rank Ben Davis among their best paying sorts.

Winesap.

This old and well known apple is one of the most important commercial varieties. It is growing in popularity and its production has been greatly increased in recent years. It is particularly adapted to the Piedmont section of Virginia and to the Yakima and Wenatchee valleys in Washington, where it is the leading variety. In the Missouri River region, at the intersection of Nebraska, Missouri, Iowa and Kansas, and also in southern Illinois, the Winesap production is increasing.

Excellent qualities of both tree and fruit make the Winesap a good commercial variety for the regions named. It is not grown commercially in New York or New England. The tree is vigorous, not particularly susceptible to any disease or insect pests, and does best on light rich soils. It comes into bearing early and is an annual cropper. The fruit tends to grow small in some sections and the tree does not thrive on heavy clay or low wet soil. Winesap apples are a stable product. They hang on the trees well, are excellent keepers, and sell well from storage. Arkansas, Arkansas Black, and Stayman Winesap are seedlings of the old Winesap.

Rhode Island Greening.

Rhode Island Greening, originating in Rhode Island about two centuries ago, is second in importance to Baldwin in New York state and its distribution throughout the northeastern part of the United States coincides largely with that of the latter variety. The Greening fits in well with the Baldwin in a farm management scheme, since it ripens somewhat earlier and very often produces a crop during the light year for Baldwins.

The tree is large, vigorous and productive, but given to biennial bearing. It prefers a fertile surface soil of gravelly or sandy loam, underlaid by a well drained clay loam. The apple-scab fungus is one of its worst enemies. Commercial plantings are almost exclusively in New York, New England, Ohio, Michigan, and the more northern parts of New Jersey and Pennsylvania. The apples are rather large and grade out well. The storage limit is usually February or March.

Jonathan.

Jonathan is a seedling of the Esopus Spitzenburg, and originated at Woodstock in Ulster County, New York. It was first described in 1826 and named after Jonathan Hasbrouck, who first called attention to the variety. The stronghold of the Jonathan as a commercial apple is in the middle western and western states. There are few commercial plantings of this variety east of the Mississippi. Jonathan is the leading sort in both Colorado and Idaho, and is important in Washington, Utah and New Mexico, being grown under irrigation in large commercial quantities in all five states. The high quality and brilliant red coloring adapts it particularly to the boxed apple industry. Irrigation overcomes its tendency towards small size. The Jonathan has rather extensive distribution through the Middle West, particularly in the loess soil region, along the Missouri River at the intersection of Iowa, Missouri, Nebraska and Kansas. Here it is a barreled apple.

In quality the fruit ranks high. The tree, although inclined to a somewhat drooping willowy habit of growth, is vigorous and yields well as it is adapted to rich soil. Under irrigation it is sometimes subject to fire-blight,

although not to such an extent as the Esopus Spitzenburg. The fruit brings high prices but is inclined to develop the Jonathan spot in storage. It is usually consumed before February and is the first of the leading varieties to be moved from the western irrigated regions. Normal harvest period is September 10th to 20th.

York Imperial.

York Imperial originated shortly after 1800 near York, Pennsylvania. It was propagated before 1830 by Jonathan Jessop under the name of Johnson's Fine Winter which it still retains in many remote parts of the South. The commercial production of York Imperial is largely confined to the valley of the Shenandoah, in Virginia, and to the Cumberland Valley in Pennsylvania, centering in Frederick County, Virginia; Berkeley County, West Virginia; Washington County, Maryland; Franklin and Adams counties, Pennsylvania. Outside of these and adjoining counties, the distribution of York Imperial is scattering and relatively unimportant, being chiefly in the Middle West. In the district defined, however, this variety is preëminent and contributes large quantities of commercial apples.

Although tending to bear biennially, it yields heavy crops and is the most reliable variety in the Shenandoah-Cumberland region where it has long been one of the leading export apples. It has a preference for heavy clay and limestone soils. The fruit is oblique, or lopsided, and is inclined to scald in storage. The fruit is also very susceptible to cedar-rust. The normal season ends in February.

Rome.

The Rome Beauty, a native of the Ohio River Valley, was first planted on the farm of Alanson Gillette at Proctorville, Ohio, in 1817, and was known as Gillett's Seedling until 1832. It has sprung to great prominence in southern Ohio and in the irrigated districts of the Pacific Northwest. The tree is vigorous, bears early, is susceptible to few diseases and insect pests, seldom breaks with a heavy load, and yields heavily in the Northwest.

The Rome Beauty, although not of the highest quality, ranks as a good commercial variety in its proper regions. It is especially desired for baking. The fruit stands up exceptionally well in storage, keeping as late as May. It is occasionally criticized for lack of color at maturity, but seldom lacks good size. Extensive plantings are not found outside of the Pacific Northwest and the Ohio Valley, but in these regions it has proved very profitable.

Northern Spy.

The Northern Spy originated at East Bloomfield, New York, in a seedling orchard planted by Herman Chapin about 1800 and was recognized by the American Pomological Society in 1852. It has a rather wide distribution throughout the northeastern part of the United States, but is declining in importance as a commercial variety. Michigan has as large a percentage of Northern Spys as any state, unless it should be Vermont, although production in the former state is many times that of the latter. The "Spy" is generally grown throughout New York, and is a farm orchard variety in many districts. It is adapted to the northermost counties of the latter state and is widely

grown in Canada. New York leads in commercial production of "Spys" in this country, followed by Michigan.

The tree is considered hardy and vigorous, although somewhat susceptible to the apple-scab. Its root system is very often used as a stock for other less vigorous varieties. One of its principal disadvantages is the lateness at which it comes into bearing. When properly matured, the Northern Spy is a high quality apple and a good keeper, but as a commercial variety it should be grown on heavy soils, as it is deficient in quality when grown in sandy soils. It is not adapted to a wide range of climatic conditions, preferring cooler regions. It matures too early south of Pennsylvania to be profitable commercially.

Yellow Newtown (*Albemarle Pippin*) (Plate XXII).

This variety is one of the oldest in America and one with very interesting historical association. The origin is credited to Long Island, in the early part of the eighteenth century. Although first grown in New York, New Jersey and Pennsylvania, its wider cultivation occurred in the Piedmont section of Virginia, particularly in Albemarle County, to which locality it is especially adapted and where it afterwards became known as the Albemarle Pippin. The Newtown is reported to have been exported to England as early as 1759 and since that time has commanded the highest prices on the English market. It is generally known as an export apple for which it is particularly adapted on account of its late keeping qualities.

The principal commercial regions for the Newtown are: the Piedmont section of Virginia, particularly Albemarle and Nelson counties; the Hood River and Rogue River valleys in Oregon; the Pajaro or Watsonville section in

California; and the Wenatchee and Yakima valleys, in the state of Washington. The Pajaro Valley, in Santa Cruz and Monterey counties, California, leads in total production of Yellow Newtown apples, having produced 1,700,000 packed boxes in 1919. These were practically all grown within a radius of ten miles of the town of Watsonville. Oregon is second. Both states, and possibly Washington, take precedence over Virginia from the standpoint of quantity produced. It may be seen that the Yellow Newtown apple is somewhat exacting in its soil and climatic requirements, since the bulk of its commercial production in the United States comes from the six or eight counties described above. It is a good commercial variety, keeps well, and commands the highest export prices. Its tendency is towards shy bearing, however, and it is particularly susceptible to apple-scab and bitter-rot and to anthracnose in the Hood River Valley. The selling price of the fruit has made it profitable in the regions described, despite somewhat low yields. Virginia and Hood River "Newtowns" are of particularly high quality.

The tree is a rather slow grower and does not come into full bearing as early as some varieties. The fruit is solid green at harvesting, developing a yellow color late in the season. As stated above, the Newtown is exacting and its selection for extensive planting should only follow careful investigation of the adaptability to a particular region.

Esopus Spitzenburg (Plate XXIII).

The Esopus, known more commonly in commercial districts as Spitzenburg, originated at Esopus, Ulster County, New York, over one hundred years ago. It is an important western boxed apple extensively grown in the Wen-

atchee and Yakima valleys, Washington, and in Hood River and Rogue River valleys, Oregon. Aside from distribution in western irrigated sections, it is grown in quantity in the Hudson and Mohawk valleys of New York, and in a more limited way in western New York.

The Spitzenburg rivals the Newtown in the Hood River Valley and ranks among the leading varieties in Wenatchee and Yakima. Fire-blight has exacted heavy tolls from the Spitzenburg plantings, in both the Yakima Valley and the Rogue Valley, Oregon, and for this reason the variety has grown into disfavor. The fruit is excellent from the standpoint of dessert, cooking and keeping qualities. The tree is inclined to shy bearing, however, and must be protected carefully from disease and insect infestation. It is more susceptible to fire-blight than any other commercity variety. Except in the Hood River Valley and possibly one or two other districts, it is not generally looked on by commercial growers as very profitable. One of the most noticeable characteristics of the Esopus is its peculiar habit of tree growth, in the form of long pole-like branches which are difficult to control in pruning.

Grimes Golden.

Originating in West Virginia, and mentioned as a commercial variety as early as 1800, the Grimes Golden has rather wide distribution throughout the state of its origin, Virginia, Maryland, Ohio Valley, middle west and western states. Important commercial quantities are produced in Washington, West Virginia, Maryland, the Ozarks, southern Ohio, Indiana, Illinois, and Missouri River region. The fruit is unsurpassed in quality, regular in its cylindrical form, and uniformly a rich golden yellow. The

skin is subject to scald in storage, but the flesh keeps well. The tree is not sufficiently hardy to withstand rigorous winters and is also subject to collar-rot, the latter tendency being one of its chief weaknesses. When planting, it should always be double worked so as to overcome this tendency. The Grimes is an important commercial variety in Missouri, a somewhat refreshing comparison with the preponderance of Ben Davis in this region. In some sections the fruit tends to be small, but invariably it is high in quality, a strong recommendation for its use in home planting and also in certain commercial areas.

Stayman.

Among the newer varieties, the Stayman Winesap stands out as one of the most worthy and one which is growing in popularity in many parts of the country. The origin is credited to a seedling from old Winesap produced at Leavenworth, Kansas, in 1866, which bore fruit first in 1875. In many ways, it resembles the old Winesap, although the coloring of the fruit is less brilliant. It is grown extensively in the Northwest, where it has proved a good yielding and profitable variety, its selling price improving as it has become better known. Old Winesap is looked on with greater favor, however, by most commercial growers in the Northwest.

The Stayman is one of the softest of the winter varieties, yet a good keeper. It tends to drop somewhat at maturity. Extensive plantings have recently been made in Ohio, Pennsylvania, and the Virginias. It is also adapted to the apple sections of the Carolinas and Georgia, having a somewhat wider range than old Winesap in this respect. Stayman production will unquestionably increase many

times since it is proving a popular variety in the eastern regions described. The tree is vigorous, comes into bearing early, and is the old Winesap in many ways. The fruit lacks some of the keeping qualities of the parent variety.

Delicious.

The Wenatchee and Yakima valleys in Washington are at present producing most of the Delicious apples which appear on the market, although extensive young plantings occur in the East, particularly in Virginia. The variety is of recent origin, being credited to Iowa, but having been planted more extensively in the Northwest than any other region. While as yet untried in many sections, it has proved profitable in certain irrigated districts of the West.

The tree is vigorous, grows to good size, and is free from any inherent weakness. The fruit is large, oblong conical, with five knob-like protrusions at the calyx end. This peculiarity gives it a distinctive appearance. The color is yellowish-red, usually striped, but sometimes more or less deep solid red. Its normal season for use ends in March, when the flesh tends to become somewhat dry and mealy. Otherwise it is a very good keeper. The Delicious apple has become very popular as a high class dessert apple on account of its very distinctive and pleasing flavor. It is the favorite fruit-stand apple in eastern cities and tops the boxed apple market in price. Its popularity with the consuming public is demonstrated by the high price which it commands.

Obviously the determining factor in the selection of this variety for commercial planting is yield. Some beautiful specimens have been produced on young trees in southern and eastern states, but whether it will prove a profitable

variety when generally planted outside of demonstrated irrigated regions remains to be seen. Performance records of full bearing commercial orchards will be the only safe guide. High quality apples are very often fastidious in their requirements for commercial success, but this variety is certainly worthy of a thorough trial.

Gano and Black Ben.

Gano was first brought to notice in Missouri about 1880. In nearly every respect the Gano is so closely identified with the Ben Davis in its distribution and general characteristics that brief treatment is sufficient. The fruit is somewhat smaller and more highly colored than the Ben Davis. The Black Ben, given as a separate variety, is considered by many as essentially the same as Gano, although it may differ slightly in some respects. Gano and Black Ben are now given preference in planting over Ben Davis in most regions.

Yellow Bellflower.

Yellow Bellflower, if not declining, has at least experienced very little increased production in recent years. It is a leading variety in the Pajaro Valley, or Watsonville district of California, where it ranks next to the Yellow Newtown in importance. It is here that a very considerable proportion of the total commercial crop of this variety in the United States is grown, 800,000 boxes being packed out in 1919, and an equal amount dried.

The Yellow Bellflower is an old variety. In 1817 Coxe reported that the original tree which was very old at that time, was still standing at Crosswicks, Burlington County, New Jersey. Scattered plantings are still found in the

states of Maine, Pennsylvania, West Virginia, Ohio and Michigan, but these are confined to old orchards. The tree grows to large size, particularly in the Pajaro Valley. Fruit is usually large but varies greatly in size, a detracting feature from a commercial standpoint. Its tender skin necessitates care in spraying and in handling.

Russets.

Russet is the name ordinarily given to a great number of different varieties of russet apples. The Roxbury and the Golden Russet are most commonly found on the market and most widely grown. They have long been in general cultivation. Others of very limited production are English Russet, Perry Russet, French Russet (Pomme Grise), Hunt Russet, Long Island Russet and American Golden Russet. Of these, English Russet and Perry Russet are much the most important, although Pomme Grise is very well known in Quebec, Canada.

The Roxbury is supposed to have originated at Roxbury, Massachusetts, about 1620. It is the most popular russet apple and is especially adapted to northern localities, New York and New England. It has proved a reliable cropper in western New York, where it ranks next to Northern Spy and above Tompkins King in commercial importance. It does not seem well adapted to the South. The fruit is usually above medium to large and variable in form, the sides often being unequal or the form elliptical. It keeps until May or June in common storage and often may be held two years in cold storage. It is of good quality, but since the cold storage has come into general use, other more generally favored varieties have detracted from its popularity and young plantings are practically unknown.

The Golden Russet ranks next in importance in the United States. It is of English origin and has long been generally disseminated. It is found extensively in the older orchards in western New York and parts of New England. Many trees of this variety occur in Pennsylvania, Ohio and scattered through the home orchards of the Middle West. The Golden Russet is an excellent storage variety and is often exported. It is also in demand for shipment to southern markets. The tree is smaller than that of the Roxbury Russet and generally less productive. The fruit also is smaller but uniform in size and less variable in shape. The flesh is more sub-acid, finer grained and of richer flavor than the Roxbury.

The English Russet is of unknown origin. It is one of the leading, if not the leading, variety in Westchester and Putnam counties, New York, and is generally disseminated throughout the Hudson Valley and southern New England. Many carloads of this variety are grown in Westchester County every year, although the orchards are not very well taken care of. The tree may be distinguished from the Golden Russet by its straight growing habit with erect shoots. According to Beach, the Golden Russet trees are more vigorous, spreading, irregular and bushy than the English Russet. The skin of the Golden Russet does not take a polish while the English Russet does. There are also differences in form of fruit. The flesh of the English Russet is inferior in flavor and of lower quality than the Golden Russet. It is not being planted and although a good keeper will soon be eliminated commercially.

Perry Russet is quite different from those described above. Its origin is unknown although thought to be

Rhode Island, as it was originally called Rhode Island Russet. It first came to commercial attention at Perry, Wyoming County, New York, and in Onondaga County, New York, where trees over one hundred years old still stand.

Tompkins King.

The Tompkins King, commonly called King, first came to attention at Jacksonville, Tompkins County, New York. However, it appears to have originated near Washington, Warren County, New Jersey, being brought to New York by Jacob Wycoff in 1804, who gave it the name King. This variety is one of the most popular of the New York varieties and has long been known and highly prized in the commercial markets of the country.

The fruit is large to very large and is fairly uniform in shape and size. It has a beautiful red color and is excellent in quality for either dessert or culinary purposes. It is well adapted for marketing, both for fancy and general trade and usually sells at an advance over more standard varieties in both home and foreign markets. In season it is best in late fall or early winter and is seldom kept in cold storage until after February. It does not retain flavor after midwinter. Tompkins King is generally cultivated throughout western New York and has proved profitable, particularly when planted on fertile well drained soils or when top-worked on thrifty hardy stock. There is often considerable loss in windfalls, on account of the large size of the fruit.

The variety is less susceptible to apple-scab than either Baldwin or Rhode Island Greening. The principal disadvantages of the Tompkins King as a commercial sort are

that it is rather unproductive, lacks hardiness, is short lived and rather hard to grow. In many parts of the country the tree is very subject to sun-scald, winter-injury and collar-rot, and the fruit is subject to water-core. Certainly this is a variety of the highest quality, and local conditions must determine whether it can prove profitable in the face of inherent weaknesses in the tree.

Arkansas (Mammoth Black Twig).

Arkansas, a seedling of the Winesap, originated in Arkansas and began to be propagated by nurserymen about 1868, since when it has become widely disseminated. Of late years this variety has been planted very extensively in Virginia, North Carolina and some parts of the Middle West. It is also found commercially in the Northwest. It keeps well in cold storage and is in season from December until May. "Black Twig" is a large red apple, rather uniform in size and only medium in quality. It brings a good price in the market, but is not recommended for extensive commercial planting as it is rather slow coming into bearing and is not a very good annual bearer. On strong soils it has a tendency to excessive wood growth and to encourage fruitfulness shallow soils are preferable. It has been much advertised and propagated, but is hardly living up to expectations and is inferior to many other standard kinds.

Wagener.

The Wagener has attained commercial importance in comparatively recent times. It was first brought to public attention in 1847 as being a new variety of considerable merit. The seedling trees from which the original Wag-

ener tree sprang were bought by Abraham Wagener in 1796 and planted on his place, now included in the village of Penn Yan, New York. Wagener has never attained any commercial importance east of Michigan, although within recent years it has been planted very extensively in the western part of that state. The other extensive plantings are largely confined to the northwest apple regions. In the Spokane district of Washington, Wagener is a leading variety, although in other western irrigated regions it is losing favor. The fruit is in season from October to February and keeps fairly well in common storage, although likely to scald in cold storage, particularly if the fruit has not been well thinned.

The tree is vigorous, comes into bearing early and is a fairly reliable cropper. On the other hand, it is short lived, rather dwarfish in form, and a slow grower as it attains full size. The fruit should be thinned, otherwise it does not attain good market qualities. The Wagener is recommended as a valuable filler to plant between rows of longer lived trees, but not for general permanent planting.

Arkansas Black.

The Arkansas Black, one of the most beautiful apples, has come into considerable prominence commercially within the last few years. It originated in Benton County, Arkansas, and first bore fruit about 1870. It attains its greatest commercial importance in the Northwest where it is boxed, particularly in the Wenatchee Valley of Washington, and to a lesser degree in the other irrigated regions. It is also grown in the Ozarks, but not to any great extent. Several young plantings occur in the East, particularly in

the Piedmont district of Virginia, and it is being recommended by experiment stations for planting in North Carolina and Virginia.

The tree is vigorous, with long slender branches, and is very regular in shape. It is hardy and grows to great size. The fruit in regions where this variety is adapted attains a large size, keeps well and commands a high price, going on the market very late in the spring. The color of the fruit is red, deepening on the exposed side to a purplish red or black. It is one of the most beautiful of all apples and, although the trees require considerable time to come into bearing, they bear fairly heavy crops when fully matured.

Willow Twig.

The Willow Twig draws its commercial importance from old plantings in a few limited areas. Before the advent of cold storage, it was known as a desirable variety for commercial use on account of its very long keeping qualities. Otherwise, it never has gained commercial favor. Its origin is uncertain, but it is thought to have been in cultivation for over a century. Extensive plantings are in Calhoun County, Illinois, also in the northern Panhandle region of West Virginia, particularly in Hancock County. The fruit is in season from January to May, but like many other long keeping varieties it is not of very good quality. The tree is a strong grower, and bears early and regularly. The fruit is not attractive although it is uniform in size and shape. The prevailing color is red with contrasting green showing through the stripes. The Willow Twig is not generally recommended for commercial planting, but limited plantings have proved profitable, largely on account of the late keeping qualities.

White Pearmain (White Winter Pearmain).

The White Winter Pearmain is well known to the boxed apple and fruit-stand trade. It retains considerable commercial importance in western Colorado, California and the northwestern irrigated regions. The origin of this variety is obscure and for a long time it was confused with several kinds of Pippins. In 1858, however, it entered the American Pomological Society catalogue as White Winter Pearmain. It is a favorite dessert apple and is in season from December to March.

The tree is vigorous and rather long lived. The fruit is uniform in size and shape and inclined to be roundish or conic in form, somewhat ribbed, but symmetrical. The skin is pale yellow with a shade of brownish red. The flesh is firm, fine grained and of superior aromatic flavor. It is not recommended for commercial planting outside of the irrigated districts in the West.

Red Limbertwig.

The widest distribution of the Red Limbertwig is in the southeastern states, particularly the Carolinas and Georgia. In North Carolina it is of much commercial importance and is the leading variety. Beach gives the Red and the Green Limbertwig as separate varieties, and it is probably the former that is so widely cultivated in the mountains of western North Carolina, although different strains, spoken of sometimes as the Royal, Sparger, Brushy Mountain or Improved Limbertwig, are credited to this region. Here it is a rather deep red apple; a good keeper, and well adapted as a commercial variety. The tree is vigorous and bears well, but has little distribution in other regions.

Yates.

The Yates is quite widely distributed over the Piedmont section of the South, but nowhere in the United States is it grown in any commercial quantities outside of Georgia; here it is undoubtedly the leading commercial variety and in many ways one of the most satisfactory. It is well known in New Zealand and Tasmania. It seems particularly adapted to Georgia conditions, and is a very heavy producer, bearing fairly regularly heavy annual crops. The tree is thrifty and healthy, and comes into bearing quite early. The fruit has long keeping qualities, is very hard and firm, and can be handled in a careless manner and still retain a good appearance. It is small in size and not of the highest quality. The Yates is very well known in southern markets, but practically unknown in the North. It is a profitable commercial variety for Georgia, but is not recommended for planting in most regions on account of its small size and lack of acquaintance with the consuming public.

Stark.

Stark is found particularly in the commercial orchards of Maine, New York, Pennsylvania and Ohio, and distributed somewhat throughout the Central West. It was first brought to notice in Ohio and is said to have originated in that state. This variety has received favorable notice in a great many regions and was offered by most of the nurserymen about 1890. It is not increasing in popularity, however, on account of poor quality.

The tree is thrifty, hardy, a reliable cropper and very productive. The fruit is smooth, uniform and keeps well.

The skin is often pale in color and not attractive, sometimes having but very little red coloring, yet at times under favorable conditions being nearly covered with red. The fruit stands handling well because it is very firm and has a thick tough skin. It keeps till June in ordinary storage and for that reason is regarded as a good apple for export trade. The variety has a wide range of adaptibility in regard to soil and climate and is recommended for planting in cases where orchards are long distances from market and the climate is rather severe. Many other varieties of its season are much superior in quality and this will prevent the Stark from attaining any great popularity.

Hubbardston.

The Hubbardston, which originated at Hubbardston, Massachusetts, has long been known to the commercial grower. Kenrick, as long ago as 1832, recommended that it was one of the most desirable varieties for Massachusetts. The commercial importance of the Hubbardston, although considerable, has never been great in any one region. It is a fairly good variety for commercial planting in the more northern sections of the country, but varies remarkably in market quality, size and color, smoothness of skin and flavor. For this reason, it is known locally in many places by other names. Normally it ripens between the autumn and the late winter varieties, comes into bearing early, is a heavy cropper and fairly annual bearer. It is somewhat susceptible to winter-injury and apple-canker and seems to be more satisfactory when grafted on to more hardy varieties such as Northern Spy. The quality of the fruit is excellent for dessert, but is excelled by many other varieties for culinary purposes. It is an uncertain keeper,

varying greatly in this respect according to the regions where grown. The fruit from western New York keeps better apparently than that from the Hudson Valley. The crop should usually be thinned since there is a tendency for a considerable portion of the fruit to be undersized and poorly colored. The Hubbardston soon loses its flavor in common storage. Few authorities now recommend it for commercial planting, although where well adapted it would seem valuable for planting as a filler.

Tolman Sweet.

The Tolman Sweet is probably the best known sweet apple grown for commercial purposes, and one which deserves even more attention than is at present given to it. It has long been grown throughout New England, New York, Michigan and more northern states, although its origin is unknown. The Tolman Sweet is best known commercially in the New England states.

The tree is vigorous, upright, open, with long branches and a form adapted to bearing an abundance of fruit. It is exceptionally productive, long lived, and very hardy, in fact one of the hardiest of all varieties. It comes into bearing at an early age and the fruit hangs well on the tree, is very uniform in grade and suffers little in loss from culls or drops. The fruit, although medium or below medium in size, is attractive for a yellow apple and is highly esteemed for certain culinary purposes, especially pickling, boiling, and baking. It is recommended as a good commercial variety, although as yet the market for it is rather undeveloped. Like the Russet it is highly prized for cider and its other good qualities are worthy of attention.

Winter Banana.

Winter Banana originated near Adamsboro, Indiana, about 1876, and was first introduced by a nursery in Monroe, Michigan, in 1890. This variety has been widely disseminated especially in the Northwest, where it has attained much commercial importance. There are considerable young plantings of it throughout the East.

The fruit is large, clear pale yellow in color except for a pinkish-red blush. The Winter Banana is a dessert apple depending on the fancy trade demand for its popularity. It is classed as a winter apple, but matures rather early and should be eaten before January first as it loses much of its flavor after that date. The tree is productive and well thought of in the Virginias and southern Pennsylvania districts, although on account of the delicacy of the fruit it is not recommended for very extensive commercial planting. It is a good apple for the home orchard and limited commercial planting.

Missouri Pippin (Plate XXIV).

The Missouri Pippin originated at Kingsville, Missouri, from seed planted about 1840. After 1860 it began to be widely disseminated through Missouri, Kansas, and the middle western states and is to-day one of the well known market apples in the Middle West. It has been planted extensively in northwest irrigated districts, particularly among the earlier plantings, but has lost favor in the West in recent years. It is not being planted in commercial orchards of any region at the present time.

The principal advantage of the Missouri Pippin is that it comes into bearing very early and yields heavily. The

PLATE XXIV.— A Nebraska orchard of Missouri Pippin trees.

fruit has a good color, but is second rate in quality and requires considerable thinning to bring it up to good market quality. It is in season from October to April. This variety is not grown throughout the East and is not now recommended for commercial planting in any part of the country.

Northwestern Greening.

The Northwestern Greening originated in Waupaca County, Wisconsin, and was first introduced by E. W. Daniels in 1872. It is widely disseminated through the north central states and is one of the leading varieties in many sections. It is also planted to a considerable extent in some of the larger orchards of the Shenandoah-Cumberland district and some of the irrigated sections of the Northwest where it finds little favor, however. It is not grown commercially in New York or the New England states.

The Northwestern Greening is a large green apple, highly attractive in color, but lacking uniformity. It is especially adapted to planting in cool regions since the tree is very hardy. The fruit has rather poor culinary quality, but rather high market qualities. In the Shenandoah-Cumberland region, this variety yields well, goes on the market early and brings high prices. The tree is hardy, vigorous and productive. It is recommended for planting in a limited way commercially in the north central states and parts of the East.

Rambo.

The Rambo is an old variety, the origin of which is unknown. As long ago as 1817, however, it was much

cultivated in Delaware, Pennsylvania and New Jersey. The Rambo is grown in considerable commercial quantities throughout parts of Ohio and the Central West. It is found also among the old orchards of the East. It is surpassed by several varieties both for culinary and dessert purposes. It is attractive when well colored, being a bright red with yellow ground color, but very often this red color is largely lacking. Under ordinary conditions, much of the fruit is not of very good market quality. The tree is more or less subject to winter-injury and breaks easily under a heavy load of fruit. The Rambo is decreasing in commercial importance in competition with better sorts.

Ortley.

The Ortley has recently attained prominence in the boxed apple regions. It is one of the important varieties of the Hood River Valley, that section producing about 100 cars in 1919. It is grown considerably in other western irrigated sections. It is highly prized as a dessert apple and is well known to the fruit-stand trade. Ortley is one of the leading varieties in Tasmania and Australia. It long ago lost popularity among growers of the East, but now seems to be gaining in favor in the West. It is an old New Jersey variety, described by Coxe under the name of Woolman's Long Pippin and was first named Ortley in 1825 when specimens of this variety were sent to London. In the East it is not found outside of the home orchards, and is rarely planted commercially except in irrigated regions. It is a large pale yellow apple of the Yellow Bellflower type and seems to attain better flavor in more southern and western climates. Ortley is not a very heavy

cropper and the fruit is rather easily bruised and tender. It is especially valuable for dessert use.

Red Canada.

This is a red winter apple, belonging to the same group as Baldwin and Esopus. It is thought to have originated in New England and was described by pomologists about one hundred years ago. The principal commercial plantings of this variety occur in Michigan where it is known as Steel's Red. It is well adapted to general and special markets and brings high prices. It should be grown on fertile or sandy soils, where it develops high flavor, color, and market quality. It is not adapted to the South. In ordinary storage, it will keep until January or April. The principal disadvantages of this variety are that it is a rather shy bearer, lacks hardiness and is but a moderate grower. It is not recommended for commercial planting and will not prove as profitable as more standard and heavier cropping varieties.

Monmouth.

Monmouth reaches considerable commercial importance only in the irrigated districts of Washington, particularly the Yakima Valley where it is known in the markets by the name of Red Cheek Pippin. It is a native of Monmouth County, New Jersey, and has long been in general cultivation throughout the East and Central West. It is grown principally only in the home orchards, there being few commercial plantings outside of the Northwest.

In season it ripens in common storage by November, while in cold storage its season may extend to January. The tree is hardy, long lived, comes into bearing moder-

ately young and is a fairly reliable cropper. The fruit is of good market quality, but if not well thinned there is likely to be considerable loss in low grade fruit. The fruit is medium to large. Its skin is yellow, faintly shaded with red and in the case of highly colored specimens the fruit has a pinkish-red blush. The variety is not important commercially.

Collins.

The Collins originated about 1865 near Fayetteville, Arkansas, and has only recently been introduced to commercial growers. It is grown considerably as a commercial variety in northwestern Arkansas, but is not generally recognized in any other district. The tree is a good grower, hardy, and has a reputation of being productive. The fruit is large, of excellent keeping quality and is in season from January to June. The flesh is white, rather coarse, only moderately juicy, and rather lacking in flavor. Highly colored specimens are bright, dark red, with a contrasting clear yellow ground color. The Collins has some attractive market qualities, but is not generally recommended for commercial planting. There seems no doubt that Ben Davis is a more worthy and reliable cropper and is of equal market quality. Collins does not bid fair to displace any other commercial variety.

Pumpkin Sweet (Pound Sweet).

Pumpkin Sweet, more commonly known as Pound Sweet, is one of the best known, easiest grown and most attractive of the sweet varieties. It originated in Connecticut and has been known in New York for about three-

quarters of a century. It is not grown commercially except in western New York and more northern localities. The fruit is large to very large. Well colored specimens become very yellow and sometimes are faintly bronzed on the exposed cheeks, but are never marked with red.

Pumpkin Sweet is esteemed as one of the best sweet apples for baking, canning, and stewing with quinces, and is prized by some for dessert on account of its peculiar flavor. It usually sells well in special markets and there is a limited general demand for it. The fruit is in season from October to January, but does not keep well in common storage. The tree is a strong grower, long lived, hardy and productive. It thrives particularly well in gravelly or sandy loam, with well drained subsoil. There is often considerable loss from water-core and from windfalls, although other than this the loss from culls or undersized apples is usually small. The variety is recommended only where the market demands a sweet apple.

Wolf River.

Wolf River is a variety of the Aport group, resembling the Alexander in form and color, although averaging larger in size. It has largely superseded the Alexander in the north central states, although both apples are popular in these regions on account of their extreme hardiness. The variety originated near Wolf River, Fremont County, Wisconsin, and was entered in the American Pomological Society lists in 1881. The tree is very hardy, a good grower, but a light cropper. The fruit is very large and often somewhat irregular in form. Flesh is coarse, tender, juicy, but low in quality. Wolf River apples sometimes sell well on local markets because of their attractive appear-

ance. The tree is not generally recommended for planting either in home or commercial orchards on account of poor quality, light yields and unprofitableness. However, many northern Michigan and Wisconsin growers have found this variety very profitable.

Sutton.

The Sutton, originating in the town of Sutton, Massachusetts, was first brought to notice by the Worcester County Horticultural Society in 1848 and was included in the American Pomological catalogue in 1877. It has not attained commercial importance until late years. At the present time, it is being planted quite extensively in the Hudson Valley and some parts of New England, and its dissemination seems to be on the increase. It has been grown in Michigan under the name of Morris Red.

The Sutton tree closely resembles the Hubbardston, of which it is supposed to be a seedling, but is much more vigorous and healthy. The fruit is of uniform size, symmetrical, has a beautiful red color and is excellent for dessert. The variety is especially adapted to the Hudson Valley where fancy trade apples are grown. The tree is a strong grower and productive but has a tendency to bear biennially. Sutton is not generally recommended for planting on any extended commercial scale and should be grown only in those regions near city markets where the fancy trade varieties are in greatest demand.

Ingram.

Ingram was originated by Martin Ingram, near Springfield, Missouri, about 1850. It has attained considerable commercial importance throughout the Ozarks. Large

plantings have been made in the more southern sections of Missouri. The tree is fairly vigorous, but is likely to bear small fruit unless thinned. The fruit is of medium quality and its chief asset is its good keeping quality. In spite of much advertising, it has not proved very popular and is not now recommended for commercial planting. It does not warrant an important place in commercial orchards, even in Missouri.

Black Gilliflower.

This variety is generally known to the trade and appears in market quotation as Gilliflower or Gills. It originated in New England prior to 1800 and has long been a market sort in a very limited way. There are very few orchard blocks of Gilliflower in the country, but it is widely disseminated in both home and commercial orchards, particularly in New York and New England. The tree is hardy, vigorous and long lived.

The fruit is of medium size and very uniform in size, shape and color. It is a dessert apple which is very distinct in color, form and flavor. The color is green, usually completely covered with red, which becomes very dark or almost black. The flesh has a peculiar flavor and aroma, but soon becomes dry and mealy. The fruit is often borne on the ends of the twigs which makes harvesting difficult. It usually brings a high price and particularly in southern markets, on account of its peculiar aroma, flavor, and attractive color. The Gilliflower is preferred by some to all other varieties as a dessert apple, but its popularity is very limited. It is not recommended for commercial planting, except in a very limited way. It is a good variety for the home orchard.

Lady.

The Lady apple is known to have been in cultivation for well over three hundred years and is thought to have originated in France. It is often seen on fruit-stands more for decoration than for eating purposes. It is a strikingly beautiful little apple, especially adapted for decorative purposes. It grows in profusion in many parts of the country, particularly in the Piedmont district of Virginia where it is produced commercially in limited quantities. Limited plantings are also found in New York state and the Northwest. The Lady apple often tops the market in price, having sold on the New York markets for as high as $25.00 a barrel when standard sorts were bringing about one-fifth as much.

The variety seems to do best in Virginia where it grows to perfection. In size it is not much larger than a crab-apple and it is very expensive to grow and harvest. On the whole, it is not to be considered more profitable than the more standard varieties. Furthermore, it is not recommended for general planting since a few acres would practically flood the market for this type of fruit. Properly handled it may be held in cold storage far into the summer, but there are few demands for it after the holiday season. The tree is moderately vigorous. The fruit is exceedingly small, somewhat lacking in uniformity; flesh is white, tender, juicy, and of high dessert quality.

EARLY AND FALL VARIETIES

Oldenburg (commercial name, *Duchess*).

Oldenburg is probably the leading early variety grown in the United States. It is one of the most valuable of

Russian apples and was introduced into this country from England by the Massachusetts Horticultural Society about 1835. The extreme hardiness of this variety proved its worth and was responsible for the introduction of other Russian sorts. It is superior in hardiness to the Baldwin, Rhode Island Greening and Northern Spy.

The tree is easily grown, requires little pruning and is an early and heavy bearer. The variety is widely known throughout the North and East, and particularly in the region bordering the Great Lakes. It is in Wisconsin, Michigan and New York that it assumes greatest commercial importance. Oldenburg is produced in carload lots in these states and particularly along the Ontario Lake shore in western New York where there are many plantings of commercial importance.

The fruit is medium to large and is uniform in shape and size, with firm, crisp, juicy flesh. It hangs on the tree well. When properly grown and handled, it stands shipment well. The fruit brings good prices and is unsurpassed for its culinary qualities. It is one of the most valuable early apples for commercial purposes.

Wealthy.

Wealthy originated as a seedling at Excelsior, Minnesota, from seed of the Cherry Crab obtained from Maine about 1860. It is one of the most important of the hardier varieties adapted to the cold climates of the northernmost states. It has wide distribution, particularly in northern Illinois, northern Iowa, Wisconsin, and Michigan, being one of the leading, if not the leading, variety of these regions. In New York and Maine, it is grown in considerable commercial quantities but in these states it is of

less relative importance as compared with other varieties. Wealthy is an early sort highly prized in New Jersey and Delaware.

The fruit is bright red, of large size and of good market quality, selling well in most markets. It is normally consumed before November and is essentially a fall apple, although it may be kept into the early winter in cold storage. Criticism is sometimes made of the Wealthy on the ground of uneven ripening and tendency to considerable variation in size and lack of color, but with good care it has proved profitable in the regions described above. It is especially adapted for planting as a filler.

Yellow Transparent.

Yellow Transparent was imported from Russia by the United States Department of Agriculture in 1870. It has since been disseminated from coast to coast and is now the leading very early commercial variety. It is grown extensively, particularly in Delaware, Maryland, Virginia, West Virginia, the Ohio Valley and especially in the early apple districts of Tennessee, Kentucky, Ohio and various other states.

Since it is about the first apple on the market, it is sought for dessert and is highly prized for culinary purposes. It grows to good size, is productive and takes on a good clear yellow color before becoming over-ripe. The crop ripens over a period of three or four weeks and more than one picking is usually necessary. Yellow Transparent brings a good price on the market and thus far has proved very profitable commercially.

Twenty Ounce.

The Twenty Ounce has proved one of the most popular of fall varieties for commercial planting. Its origin is unknown, but it was first brought to attention when fruit grown in Cayuga County, New York, was exhibited before the Massachusetts Horticultural Society about seventy years ago. It is one of the most important fall varieties grown in New York, being particularly important in Monroe and other western counties in the Lake Shore region.

The fruit is large and attractive, being green and later yellowish with broad stripes and splashes of red. In New York it is in season from September to early winter, while in New Jersey and Delaware it comes on the market in August. The Twenty Ounce keeps very well for a fall variety and stands shipping well. It is usually handled without going into cold storage, although it may be kept until midwinter in storage. The fruit is fairly uniform in size, is of good marketable quality and is well known in eastern commercial markets where it brings good prices. The tree is vigorous, with erect main branches, but more or less willowy and drooping laterals. The trunk and larger limbs are especially subject to sun-scald and canker. Closer planting may be practiced than with Baldwin, Rhode Island Greening, Northern Spy, York, or other varieties, which attain considerable size. Twenty Ounce is recommended for commercial planting in Delaware, New Jersey, and many parts of New England and New York.

Gravenstein.

Gravenstein was introduced into this country from central Europe early in the nineteenth century. It is of

much commercial importance for a variety of its season, which in the Northeast is from September to November. The largest commercial plantings of this variety are in Sonoma County, California, which ships annually about 500 cars of boxed Gravensteins. Gravensteins are grown in a limited way through the other far west and northwest districts. Commercial plantings also occur in New Jersey, Delaware, the Hudson Valley, New England and are particularly important in Nova Scotia. The fruit is found on the New York market during the autumn in large quantities.

Gravenstein is of very attractive appearance and of excellent quality. It is practically unexcelled for culinary purposes and is highly prized as a dessert apple, being usually in strong demand and commanding good prices. There is likely to be considerable loss from dropping since the fruit does not color evenly and requires two or three pickings. The tree comes into bearing moderately early and is a fairly reliable cropper. It is large, vigorous, and hardy, and adapted to many climates. The Gravenstein's place as a commercial variety is assured.

McIntosh.

The McIntosh belongs to the Fameuse group and is adapted to a wide range of localities, although the districts where it grows commercially are limited. It originated as a chance seedling on the McIntosh farm in Dundas County, Ontario. Allan McIntosh began its propagation about 1870. Its dissemination and cultivation is on the increase. In season it varies from an early fall apple in the South to late fall or early winter apple in Canada. In New York

it begins to ripen about October first. The fruit is very attractive in appearance and the flesh is tender, perfumed and delicious. It may be kept in cold storage until the first of the year. The fruit is susceptible to scab and has a tendency to ripen unevenly and to drop. The trees are generally hardy, come into bearing young and have a tendency to biennial bearing. The variety is grown commercially in northern New York, Vermont, particularly on Grand Isle, in Lake Champlain. Considerable commercial plantings are in the Hudson Valley, southern New Hampshire, Massachusetts, and Connecticut, where it does particularly well. It is the leading commercial variety of the Bitter Root Valley of Montana and is grown in the commercial orchards of Idaho, Washington and British Columbia. It usually commands a very good price in the market and is highly prized, especially for dessert purposes. Nearly all McIntosh apples enter commercial channels.

Maiden Blush (*Lady Blush, Red Cheek*).

Maiden Blush is one of the most widely grown of all fall apples and is found to some extent in practically all the central, eastern and southern apple-growing states. It is grown in considerable commercial quantities in northwest Arkansas, Missouri, Illinois, Indiana and Ohio, and to a lesser extent commercially in New York and the Atlantic seaboard states. It was well known in the Philadelphia market over one hundred years ago.

The tree is medium in size and moderately vigorous, comes into bearing young and is a reliable cropper. Maiden Blush is a standard market variety and usually

sells above those of its class. It is good in quality and is valued for many uses. It makes very white evaporated stock.

In season it varies from a summer apple in the Ozarks to a fall apple in the North, keeping until December 15th in New York. The fruit is a beautiful pale yellow color with crimson cheek, which adds to its popularity. Its disadvantages are that it is not a particularly good shipper and keeper, and ripens somewhat unevenly, with a tendency to drop. Its place in the commercial orchard is assured, although its production is not likely to increase.

Fameuse (*Snow*).

The Fameuse is thought by some to be of French origin. It was grown in Quebec at a very early date, possibly as long ago as 1600. It has long been recognized as an important commercial variety and is one of the most valuable dessert apples of its season. It is well distributed throughout the northern states, particularly Michigan, New York, and New England, and is especially adapted to cold climates. Fameuse is grown commercially principally in the Champlain district of New York and Vermont, the St. Lawrence Valley, and in the commercial districts of Wisconsin, Michigan and eastern Canada. It is found in home orchards in many northern localities. It is well known in the market and during its season, which is from October to January, it is in good demand and usually commands high prices.

The fruit is particularly susceptible to apple-scab fungus. It is small to medium in size. The flesh is white, very tender, aromatic, juicy, and when ripe is mildly sub-

acid. The skin is bright red, deepening to an almost purplish black. The tree is hardy and vigorous. The Fameuse is not being extensively planted in the United States, its place being largely taken by the McIntosh.

Williams (*Williams Early Red, Williams Favorite*).

Williams originated in Roxbury, Massachusetts, nearly 175 years ago. It was brought to the notice of the Massachusetts Horticultural Society and named Williams in 1830, and was entered in the American Pomological Society catalogue in 1854.

It is one of the most valuable varieties for the commercial market and is being planted to a considerable extent throughout New England, the Hudson Valley, New Jersey, Delaware and Maryland. It is also recommended for planting throughout the South. In season it varies from September 1st in New England to July 1st in Carolina. Williams is a large bright red apple of very attractive appearance and with a pleasant, mild sub-acid flavor, unless over-ripe, when it becomes dry. It comes into bearing early and yields fair to good annual crops which bring high prices in the home commercial market. The apple is highly prized for export. It is recommended as a good variety to plant where an early commercial sort is desired.

Benoni.

Benoni is an early apple of commercial importance in the Middle West. It originated at Dedham, Massachusetts, and was introduced about 1832. It is a fine dessert apple of excellent quality, inclined to be conical in shape. The flesh is yellow, fine grained, crisp, juicy, and pleas-

antly sub-acid. It begins to ripen early in August and extends into September. The tree is large and vigorous and comes into heavy bearing moderately young and yields good biennial crops. Its commercial production in carload quantities is mostly confined to the early apple section of southern Illinois, particularly Johnson and Union counties where it ripens the first of July. Its production is not increasing and it finds little favor in the East.

Bonum (*Magnum Bonum*).

Bonum is well known in the Piedmont district of Virginia and North Carolina. It is highly prized in these states as a commercial variety and invariably commands good prices. It originated in Davidson County, North Carolina, early in the last century, but has never been disseminated to any extent outside of the Piedmont region. It is important commercially in several North Carolina counties and particularly in Rappahannock and Patrick counties, Virginia, where it is planted in solid blocks and produced in carload lots.

The tree is moderately vigorous and comes into bearing early. The fruit is of medium size, superior quality, with yellow skin, mostly covered with crimson and dark red. The flesh is white, often stained next to the skin. It is tender, juicy, and has a peculiar aroma. It is highly prized as a dessert in the southern markets.

Its season extends from September to about December 1st. This is a profitable variety only in certain regions and does not yield as heavily as the more standard sorts. It also has a tendency to drop and has a short picking season. Its place in the commercial orchard is assured, although it will never be grown in considerable quantities

on account of its season. It is very valuable for home orchards of the South.

Red Astrachan.

Red Astrachan, one of the best known and most widely disseminated varieties, originated in Sweden and was known in England as early as 1816. It was introduced in this country in 1835 by the Massachusetts Horticultural Society. The variety is well known commercially in Monmouth County, New Jersey, in Delaware and to a limited extent throughout the northern tier of states as far west as the Missouri River. It is a beautiful early summer apple, of medium size, yellow, largely covered with light and dark red stripes, very often a bluish bloom. It is highly prized for culinary and dessert purposes.

The tree is medium in size, a strong grower, moderately long lived, an early bearer, and a reliable cropper. It is necessary to make several pickings as the fruit ripens very unevenly and there is likely to be considerable loss from dropping. The Red Astrachan is not very uniform in size and is a poor shipper. It is well suited for local trade demand, but not at all for distant shipping. Red Astrachan is so common throughout the home orchards that local markets are generally well supplied. Commercial plantings are not generally recommended.

Early Ripe.

This is a well known early commercial variety particularly adapted to New Jersey, Delaware and Pennsylvania, where it has attained considerable commercial importance. It is one of the leading commercial apples of New Jersey. The tree is large, vigorous, and a fairly good cropper,

although it has a tendency to biennial bearing. Fruit is medium, fairly uniform in size, rather inclined to be conical, irregular and broadly ribbed, with short thick stems. Its season is July and August. Early Ripe trees come into bearing young and are well adapted as fillers or for permanent planting in certain regions. Some large orchards of this variety are in southern New Jersey and in the intensive apple sections of Delaware. It is recommended for planting in these districts.

Alexander.

This apple is of the Aport group introduced from Russia to England in 1817, later to this country where it is only grown in limited commercial quantities. The tree is usually exceptionally hardy, vigorous and moderately productive. It is subject to blight in some localities. Its season in the North begins in September and extends through October. It is often in strong demand in the market and has proved a highly profitable variety for those who have grown it in a commercial way. One of the best commercial orchards of this variety is at Hilton, New York. It is particularly adapted to northern climates and is widely grown in Canada.

The fruit is large and uniform in size, attractive, red striped, medium in quality and suitable more for culinary purposes than for dessert. It brings high prices but since the demand is limited it is not recommended for commercial planting except in a small way, or as a filler.

Starr.

The Starr is an early variety of commercial importance only in sections of New Jersey, Delaware and Maryland.

Rather extensive plantings are in the district about Burlington County, New Jersey. The original tree was found on the grounds of Judge J. M. White at Woodbury, New Jersey, and was first propagated by William Perry in 1865 under the name of Starr.

The tree is moderately vigorous, comes into bearing young and has a reputation of being a good annual bearer. The fruit is large, very attractive for a green or yellowish apple, very good in quality and especially for dessert use. It is highly prized for the early market and is one of the leading commercial varieties of southern New Jersey. Its season is July to September. At the present time, most of the fruit of the Starr is shipped in hampers or in five-eighths-bushel baskets. The Starr is recommended for commercial planting in New Jersey, but not in New York or more northern districts.

Red June (*Carolina Red June, Carolina June, Carolina Red*).

Red June is a southern apple, supposed to have originated in North Carolina. It has long been known commercially and is grown in many sections, particularly in southern Illinois and in various early apple districts of the southern states, as well as to a limited degree in New Jersey and Delaware. Red June tops the early market in price in many sections and is particularly important in southern Illinois production. The fruit has a very attractive deep red color, is inclined to be oblong, with unequal sides, but is fairly uniform in size and shape.

The tree bears well, is remarkably vigorous and has an upright habit of growth, with short, straight, slender twigs. The fruit ripens very unevenly so that several

pickings are necessary. This variety is well suited for early fancy trade demand, and although it requires considerable care will prove profitable when grown in proximity to early markets.

Chenango (*Chenango Strawberry*).

The Chenango, commonly called Chenango Strawberry or Strawberry, was first brought to attention in Chenango County, New York. This variety has long been a favorite in home orchards and special markets. In dessert and culinary qualities it is unsurpassed. It has a very characteristic aroma and flavor which it still retains when cooked.

Under favorable conditions the tree is a heavy bearer, usually biennial. The fruit begins to ripen in southern Illinois, where it is grown in considerable commercial quantities for shipment, about the last of July and the ripening period continues for several weeks. It should thus have several pickings. In New York and New England, where it is a favorite home orchard variety, it does not begin to ripen before September.

The tree is hardy, long lived and an early bearer. The fruit varies in size from small to very large. It is yellowish white, striped with red, and usually elongated, oblong conic in form, although it is particularly subject to variation in quality and form, trees in the same orchard often producing widely different types. It is one of the most attractive apples, is unsurpassed as a home orchard variety and has proved very profitable when grown in limited quantities for special local markets. It is usually marketed in hampers or baskets. The fruit ripens too unevenly and is too variable in size for a standard variety. It is also a very poor shipper.

Fall Pippin.

The origin of the Fall Pippin is unknown, but it is certain that the variety has been cultivated for many generations since there are trees in New York orchards which are now over one hundred years old. Although a good variety for the home orchard, the Fall Pippin is not widely grown or recommended outside of the Hudson Valley and certain limited areas.

The fruit is very large, tends to ripen unevenly, but when fully ripened has an attractive yellow color and a peculiar flavor. The flesh is tender, rich, and of fine quality, being excellent both for dessert and culinary purposes. The apple is desired by the export and by fancy trade, particularly in the vicinity of New York. Its season is from September to January. The tree is large, vigorous, hardy, and very long lived, but the fruit and foliage are especially subject to attacks of apple-scab fungus and thorough preventive measures are necessary in order to grow the Fall Pippin successfully. While not recommended for general planting, this variety would doubtless prove profitable in the more northern regions where there is a local or fancy trade demand.

All the foregoing varieties are grown commercially to a greater or less extent. There are other sorts such as Early Harvest, Smith's Cider, Smokehouse, Fallawater, Swarr, Sweet Bough, Westfield, and a great many others which are well known to the home orchardist, and widely listed in nursery catalogues, but which are not important commercially in any part of the country, and for this reason are not described in this discussion. It might be well to mention that such varieties as Lowry, Virginia

Beauty, King David, Opalescent and certain others are being planted with considerable success in certain localities. Lowry and Virginia Beauty are in favor in parts of Virginia and North Carolina, while Opalescent is found in Ohio. King David is quite widely disseminated and is being planted considerably. English Codling, Champlain, Pennock or Pelican are found in a commercial way in Monmouth County, New Jersey. Golden Delicious has not yet attained commercial prominence but in a decade will no doubt be one of the best prized apples.

The varieties which have been given detailed description will represent practically the entire commercial crop of the United States. The first twelve described represent nearly 80 per cent of the entire commercial production of this country. This serves to emphasize the importance of recognizing and planting only such varieties as are of some commercial importance or promise. Hundreds of other kinds might be named which appear in nursery catalogues, but the greater portion of these are valueless either as home orchard varieties or for commercial planting.

There are many new and much advertised varieties which are not discussed for as yet they are of little or no commercial importance and several years' trial will be necessary to determine their true value. However, there is plenty of opportunity for new varieties if they are really superior to the standard sorts of to-day and experiment stations are doing valuable work in developing apples of superior quality. Before planting any new variety on a large commercial scale, it should be very highly recommended by at least two or three experiment stations which have given it a thorough trial. Golden Delicious is one

of these very new varieties which certainly is worthy of a thorough trial commercially.

STATUS OF COMMERCIAL VARIETIES

It is of importance to discuss the relative status of the various commercial varieties and the reasons for their increase or decline.

Commercial varieties the production of which is on the increase, and the outstanding reasons for this:

Variety.	*Reasons for increase in commercial orchards.*
1. Jonathan	Early bearer, high in color, fine in flavor, good shipper.
2. Stayman	Good size, fine keeping quality, very productive, agreeable flavor.
3. Delicious	Quality par-excellence, attractive appearance, fancy trade demand.
4. Winesap	Productive, hardy, excellent quality, regular bearer.
5. Rome	Good size, uniform, attractive appearance, productive, excellent cooking and baking qualities.
6. Williams Early Red	Fancy trade demand both local and export, attractive appearance, good quality, good shipper.
7. York Imperial	Very productive, excellent culinary and shipping qualities.
8. Oldenburg (Duchess)	Fine culinary qualities, hardy tree, fruit uniform in size and shape, early bearer, productive.

Variety.	*Reasons for increase in commercial orchards.*
9. Grimes	Excellent quality — both dessert and culinary, fancy trade demand.
10. McIntosh	Attractive appearance, excellent dessert qualities, fancy trade demand, very hardy.
11. Wealthy	Uniform in size and shape, hardy, productive, early and reliable cropper, excellent market quality.
12. Yellow Transparent	Very early, productive, excellent culinary qualities, attractive appearance.
13. Arkansas (Black Twig)	Large size, attractive, excellent for baking, fairly productive.
14. Arkansas Black	Large and most attractive appearance. Extremely good keeper and shipper.
15. Winter Banana	Early bearer, fine appearance, high quality, fancy trade demand.
16. Golden Delicious	A new variety being recently planted, productive, high quality combining many qualities of Grimes and Delicious.

The above varieties owe their popularity to widely different reasons. Delicious, McIntosh, Grimes and Winter Banana are in demand by the fancy trade on account of their excellent dessert quality. With the exception of Grimes, they are as yet used little for culinary purposes. Arkansas Black, although of rather inferior quality, is utilized by the fancy trade late in the season. The other varieties are more in demand by the general trade. The disadvantage which some of the apples have in quality

of the fruit is overcome by hardiness of tree, and by shipping and keeping qualities. Certain varieties are decreasing in some sections and increasing in others. Arkansas (Black Twig) is out of favor with so many growers that its continued popularity is questionable. York is increasing in popularity only in the Shenandoah and Cumberland Valley districts of the Virginias, Maryland and Pennsylvania. Stayman is almost universally on the increase.

The production of the following varieties is practically stationary, the new plantings about taking the place of those which are going out: Baldwin, Rhode Island Greening, Yellow Newtown, Gravenstein, White Winter Pearmain, Northwest Greening, Twenty Ounce, Gano, Wagener, Maiden Blush, Alexander, Benoni, Bonum.

Of these, the Baldwin, Rhode Island Greening and Yellow Newtown are very important commercial varieties and will remain so. The reason why they are not on the increase is due to the fact that the new plantings, although very large, are not sufficient to overcome the decline in production of the thousands of old orchards throughout the East. Yellow Newtown is increasing in the Northwest. Other varieties are decreasing in some sections and increasing in others. Gravenstein is growing in a strictly commercial way in New Jersey, California and parts of New England. Wagener, although in much favor in the Spokane district of Washington, parts of Michigan and other limited sections, is losing popularity in western Colorado, Wenatchee and Yakima valleys, and is now planted only to a very limited extent in the East.

Gano is planted much less than formerly and is classed by most persons with the Ben Davis, although Black Ben is being grown quite extensively. Due to many young

plantings, Gano and Black Ben are increasing in production in the Northwest and boxed apple states.

The White Pearmain and Northwest Greening are important varieties in particular localities. They tend to hold their own.

Maiden Blush is widely disseminated and brings good prices in the commercial market. It is not on the increase, due to the limited demand for its class of fruit and the great number of old trees of this variety which are going out.

Alexander and Benoni are grown only in a limited way commercially, and are striving to hold their own against the Duchess and Yellow Transparent.

Twenty Ounce is in favor in certain sections of New York, New Jersey and Delaware, but its susceptibility to canker has checked planting.

Bonum, important in certain southern markets, and of superior quality, is at present largely dependent on Rappahannock and Patrick counties, Virginia, and western North Carolina for its continued commercial importance.

The following varieties are declining in commercial importance and in another generation many of them will have disappeared from the commercial orchards. Many of these varieties are among the most important in the country, but they evidently are not as generally profitable as others which, for various reasons, excel them in a combination of qualities.

Variety.	*Reasons for decline in commercial orchards.*
1. Ben Davis	Low quality, susceptible to blister-canker.

Variety.	*Reasons for decline in commercial orchards.*
2. Northern Spy	Slow to come into bearing; high cost of production.
3. Esopus (Spitzenburg)	Very suspectible to disease, especially fire-blight, light bearer.
4. Tompkins King	Tree short-lived, fruit inclined to water-core, high cost of production.
5. Roxbury and Golden Russet	Former popularity due to long keeping quality in common storage; place now taken by apples of superior market quality; difficult to harvest.
6. Hubbardston	Loses flavor in storage, tends to bear much undersized and poor colored fruit.
7. Missouri Pippin	Short lived tree, fruit of third rate quality and small in size.
8. Tolman Sweet	Decline due to fact it is a sweet apple; deserves more attention.
9. Fameuse	Susceptibility to apple-scab, place in market being taken by McIntosh.
10. Yellow Bellflower	Requires great care in handling, not regarded as a satisfactory cropper on most soils in the East.
11. Stark	Does not color well, poor quality.
12. Smokehouse	Difficult to develop fruit of good color and quality. Other varieties much better suited to culinary uses.
13. Smith Cider	Does not rank high in market quality, and does not develop in size in many regions.

Variety.	*Reasons for decline in commercial orchards.*
14. Willow Twig	Poor quality. Has declined since advent of cold storage.
15. Red Limbertwig	Only fair quality, market price below the average, place taken by superior cold storage varieties.
16. Westfield (Seek-no-further)	Fruit variable in color, usually lower in price than other commercial varieties, lacks culinary qualities.
17. Black Gilliflower	Does not hold flavor, difficult to harvest, limited demand.
18. Ralls (Genet or Geniton)	Requires much thinning, rather small in size, poor appearance.
19. Fall Pippin	Very susceptible to apple-scab, ripens unevenly, lacks storage qualities
20. Rambo	Leading commercial varieties are superior in quality and uses, does not keep well in storage.
21. Huntsman	Susceptibility to bitter-rot, sunscald and scab; tree slow to come into full bearing.
22. Ingram	Second rate in quality, medium size.
23. Wolf River	Fruit too large, lacks storage qualities, moderate cropper, poor dessert quality.
24. Collins	Lacking in dessert quality, flesh coarse and lacking in flavor.
25. Lawver (Delaware Red)	Lacking in dessert quality, not a very reliable cropper, place taken by cold storage varieties of superior quality.
26. Blue Pearmain	Not a reliable cropper, rather

Variety.	Reasons for decline in commercial orchards.
	low in quality, poor storage variety.
27. Buckingham	Poor shipper, moderate quality and irregular bearer.
28. Fallawater	Coarse flesh, superseded by other late keeping varieties of better quality.
29. Swaar	Tree lacks longevity, moderate cropper, lacking in attractive appearance.
30. Red Canada (Steele's Red)	Delicate tree, light and uncertain cropper.

Of the above varieties, Ben Davis, Northern Spy, Esopus and Yellow Bellflower are of great importance in the commercial market. Ben Davis, formerly planted to the exclusion of most other apples in Missouri and many parts of the Middle West and South, is showing a rapid decline. Not only are comparatively few Ben Davis now being planted, but thousands of the old orchards are dying out through the ravages of the blister-canker and general neglect. Virginia is taking the best care of its Ben Davis orchards.

While it is true that the Ben Davis is of low quality, its cost of production is very low as compared to most apples. Due to its heavy bearing qualities, it has proved very profitable in many regions. Growers to-day would make no great mistake in planting Ben Davis in those regions outside of the irrigated sections where it is well adapted. It is very suitable for culinary purposes and its low dessert quality should not overbalance its recognized keeping qualities and productivity.

Northern Spy, although one of the highest priced and highest quality apples grown, is being superseded by varieties which are earlier and heavier bearers, and whose cost of production is much less. It will retain its place in many localities, however, and will no doubt always be grown in commercial quantities, particularly in northern New York, Michigan, Vermont and Canada. It has no place in the Northwest, Central West or South.

The Esopus Spitzenburg is declining rapidly in the East, and few commercial orchards now exist outside of Oregon, Washington and California. It is grown in large quantities, especially in Hood River and Wenatchee valleys. On account of the susceptibility of the trees to disease, however, it is being planted to a much less degree than formerly, even in its most favored regions. The very high dessert and market quality of the fruit, which is practically unsurpassed in this respect, has kept this apple in the commercial orchards.

Tompkins King, excellent both for dessert and culinary uses, is hardly suitable for commercial orchards, for the same reasons as the Esopus. It brings high prices but requires great care in growing and is particularly subject to damage by windstorms. Its planting is now being largely limited to home orchards.

Roxbury Russet, Golden Russet, Willow Twig, Smokehouse, Missouri Pippin, Fallawater, and Lawver owed much of their former popularity to their ability to keep well in cellars or common storage. With the advent of the cold storage, these varieties lost much of their importance and are now seldom planted in commercial orchards.

Yellow Bellflower, although important in the aggregate

number of trees in the United States, is grown in a commercial way only in the Pajaro Valley of California. It bids fair to retain or increase its importance there, but the trees in the East are nearly all in old orchards, and are rapidly going out.

Smith Cider has always been largely limited to home orchards, particularly in Pennsylvania, New Jersey and mid-eastern states. Although this is an old and once valuable variety, it is now seldom planted.

Red Limbertwig, the leading commercial apple of North Carolina, is being superseded by Arkansas (Black Twig), Stayman and other recognized commercial varieties which surpass it in quality and market demand.

Fall Pippin and Fameuse are autumn or early winter apples which are losing their place in the commercial orchards, due principally to the development of other varieties of equal or better quality. They will always be grown to some extent commercially, particularly the Fameuse.

AGE VARIETIES BEGIN TO BEAR

The age at which trees attain bearing varies greatly with the variety and also somewhat with the region. In the Northwest, and particularly in the Wenatchee and Yakima valleys, some varieties are in profitable bearing at six years and are bearing full crops at ten years of age. In the East, however, the time required for trees to attain full bearing is from three to eight years longer. Trees in Virginia come into bearing earlier than those in Michigan or in New York, while bearing age for the Central West might be given as midway between that for New York and Virginia. New England is a region in which trees attain full bearing at rather advanced ages.

The following classification arranges most of the important commercial varieties into three groups according to the time at which they reach bearing. In the first column are those which are known as early bearers in practically every region in which they are grown. In the last column are those which are generally classed as late bearers, while in the middle column are varieties which grade between early and late bearers. Some variation will be found, of course, in different regions.

Early.	Medium.	Late.
Wealthy	Winesap	Delicious
Wagener	Ben Davis	Arkansas Black
Duchess	Gano	Tompkins King
Jonathan	Maiden Blush	Arkansas
Missouri Pippin	Alexander	Yellow Newtown
Twenty Ounce	R. I. Greening	Yellow Bellflower
Yellow Transparent	Williams Early Red	Esopus
McIntosh	Grimes	Northern Spy
Rome	Stayman	Stark
	Baldwin	
	York Imperial	

Of the varieties listed, Northern Spy is probably slower to come into bearing than any other, while Oldenburg (Duchess), Yellow Transparent and Wealthy, are among extremely early bearers. The latter three varieties begin to bear at about five years of age, even in New York state, while the Northern Spy can not be expected to have a good commercial crop before it is at least fifteen years of age, and is not in full bearing until it is twenty-five. The following examples will show the wide variation in full bearing age for different regions: in the Wenatchee Valley an orchard is considered in full bearing at ten to twelve years; in New York not generally before twenty to twenty-five years; in Virginia it requires about fifteen years, with

the exception of the Yellow Newtown plantings, which require a somewhat longer time.

Most of the late bearing varieties are of high quality and all are in demand on the general market. However, it is on account of their very late bearing tendencies that many of them are not planted to a greater extent. It should be remembered that late bearing does not mean unproductive. Varieties which are late in coming into bearing are often more productive than the early bearing sorts.

RELATIVE PRODUCTIVITY OF VARIETIES IN FULL BEARING

It is difficult to arrange varieties in columns according to productivity, because many are very productive on some soils and unproductive on others, and also productive in certain regions, while not at all adapted to others. In general, however, twenty of the well known commercial varieties might be arranged as follows somewhat in order of productivity:

Heavy to Medium Bearing Varieties.	Medium to Light Bearing Varieties.
1. Ben Davis	1. Yellow Newtown
2. Stayman	2. Winter Banana
3. Baldwin	3. McIntosh
4. Stark	4. Arkansas
5. York Imperial	5. Arkansas Black
6. Winesap	6. Grimes
7. Rhode Island Greening	7. Delicious
8. Rome Beauty	8. Wagener
9. Wealthy	9. Esopus
10. Northern Spy	10. Red June

Ben Davis, although undoubtedly the heaviest bearing

of all commercial varieties, is at the same time usually the lowest in price on the commercial market, while Red June, probably producing about the lighest crop of any commercial apple, usually tops the market in its season. Quality is to be considered as well as the bearing tendencies when selecting varieties.

RELATIVE HARDINESS OF COMMERCIAL VARIETIES

Hardiness and health of tree plays an important part in selecting varieties and should be considered especially in severe climates. The following are well known as hardy sorts:

Northern Spy	Wealthy
Ben Davis	Baldwin
Fameuse	Yellow Bellflower
Yellow Newtown	Gravenstein
Tolman Sweet	Williams Early Red
McIntosh	Alexander
Winter Banana	Delicious

The following varieties lack hardiness:

Tompkins King	Grimes
Twenty Ounce	Sutton
Esopus	Canada Red
Hubbardston	

One might mention a great many other varieties which would fall midway between these two groups, or might add several to each group, but the more important in each extreme are named above. Of the hardy varieties, McIntosh deserves particular mention. It withstood the severe winter in 1917 in the Champlain district of New York and

Quebec, when trees of such well known and hardy varieties as Northern Spy, Fameuse and Ben Davis were killed in the same orchards.

VARIETIES IN GREATEST DEMAND

In the selection of varieties, it is important to consider those which are in great demand in the commercial market, and which ordinarily bring the best market prices. This sort of selection will often eliminate many hardy or productive varieties which are not generally in great demand by the consuming public. The following are well known and sought after in the general markets:

Late Varieties.	Early or Fall Varieties.
Baldwin	Yellow Transparent
Tompkins King	Red June
Esopus	Oldenburg (Duchess)
Rhode Island Greening	Gravenstein
Stayman	Williams Early Red
Delicious	Bonum
Winesap	Wealthy
Jonathan	Twenty Ounce
York Imperial	McIntosh
Northern Spy	
Grimes	
Yellow Newtown	
Rome Beauty	
Ortley	
Winter Banana	

Of the above named late varieties, Esopus, Tompkins King, Grimes, Northern Spy, Delicious, McIntosh and Ortley usually outsell all others, while Winesap and Jonathan excel the Stayman, Baldwin, York and most other varieties in barreled apple sections. In the early market

Yellow Transparent, Oldenburg (Duchess) and Wealthy are probably the three best known varieties, although they do not usually sell for such high prices as some of the special sorts like Red June.

EXPORT VARIETIES

Varieties might be divided further into three classes as follows: (1) those for special or local markets, (2) those for general market, and (3) those for export market. Extensive planting of varieties which are only adapted for special markets is not recommended. It is better to plant general market varieties which are adapted to special markets as well. In considering the export market, it is necessary to eliminate some general market varieties. The following ten or twelve varieties have proved most satisfactory for the export trade:

Barreled	Boxed
Baldwin	Yellow Newtown
Yellow Newtown	Winesap
York Imperial	Jonathan
Ben Davis	Esopus
Northern Spy	White Pearmain
	Ortley

Yellow Newtown, York Imperial and Baldwin have up to the present time been the favorite export varieties.

VARIETIES FOR THE HOME ORCHARDS

In selecting varieties for the home orchard, an entirely different system should be used than for commercial planting. Flavor and keeping quality are the two predominant qualities to be considered. Annual yield, shipping

qualities, appearance and market demand should not materially affect the selection of varieties for a strictly home orchard. Very often apples which conform to commercial standards are inferior in quality to certain sorts which may be grown at home. Suitable varieties for the home orchard are very often too tender to ship or are too irregular in their bearing habits to prove profitable in a commercial way.

Varieties most valuable for home use are seldom listed by many nurserymen, while commercial varieties not at all adaptable for the home orchard are often given as suitable. Nursery catalogue descriptions of varieties are not only meagre, but are too general in many ways and at times are misleading. Such descriptions as "fine quality," "very productive" and "excellent for the orchard" have been applied to practically every apple offered by nurserymen. This criticism, of course, does not apply to all catalogues, but one has only to read over the list of varieties offered by several nurseries selected at random to see how widely descriptions differ and to note the number of odd and practically untried varieties listed. A great number of new and odd varieties offered by nurserymen are much inferior in quality to standard sorts.

To name the varieties suitable for home orchard purposes would entail a very large list, if seasonable demands and also varying soil and climatic conditions were considered. Among the commercial varieties suited to home orchard use generally throughout the North and central states are Northern Spy, McIntosh, Fameuse, Baldwin, Grimes, Gravenstein, Tompkins King, Esopus (Spitzenburg), Delicious, Stayman, Yellow Newtown, Oldenburg (Duchess), Winter Banana and Rhode Island Greening.

In the more southern regions, Grimes, Delicious, Winesap, Stayman and Yellow Transparent are valuable, while Bonum, Virginia Beauty and Yellow Newtown are of particularly high quality when grown in the mountain districts of the South. Many others are suitable, but the above are excellent commercial sorts as well as for the home orchard. Varieties not particularly suited for the home orchard are Ben Davis, Gano, Rome Beauty, Bismark, Wolf River, Blue Pearmain, Pewaukee, Mammoth Black Twig, Arkansas Black, Willow Twig, Missouri Pippin, Smith Cider, Smokehouse and many others. Some sweet apples find little place in commercial orchards, but have superior flavor and are unexcelled for dessert and boiling purposes. The Victoria Sweet, a very tender, juicy and rare flavored apple in season from October to January in the North is one of these, Jersey Sweet, a month earlier, being another. Sweet Bough is the best summer sweet apple, excelling all others in dessert quality.

Pound Sweet is a late fall and winter variety which is valuable, even commercially, and the same is true of Tolman Sweet. The last named is one of the best apples grown for household use.

Old varieties like Black Gilliflower, Roxbury and Golden Russet, Westfield Seek-no-further, Yellow Bellflower and Jeffries are valuable in the home orchard. Chenango is one of the very finest apples for the home orchard, unexcelled in fine dessert quality. Its season is July in southern Illinois, August in Ohio and September in New York.

It is always well when setting out a home orchard to get in touch with the horticultural extension department of

the state and obtain the advice as to varieties for any particular locality. Also if a variety can not be secured from any particular nursery, the information as to where it can be obtained may be received on inquiry of the office of Pomological Investigations, Bureau of Plant Industry, Washington, D. C.

INDEX

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